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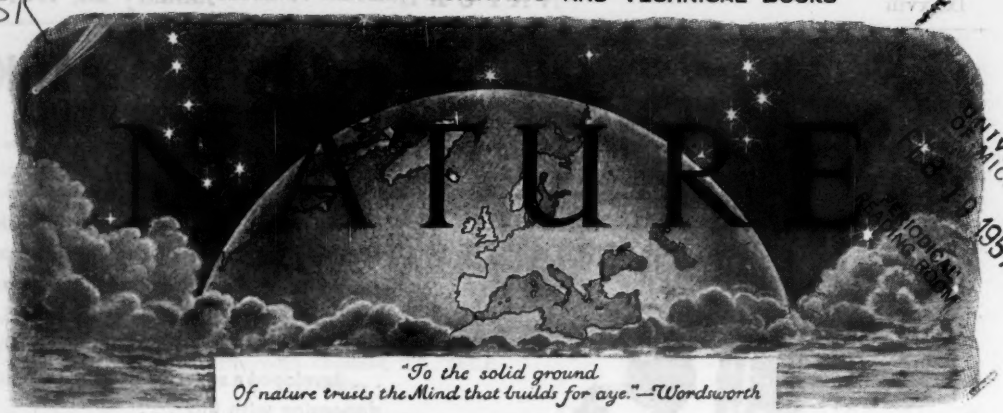

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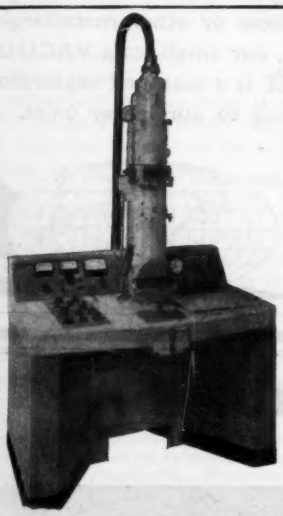

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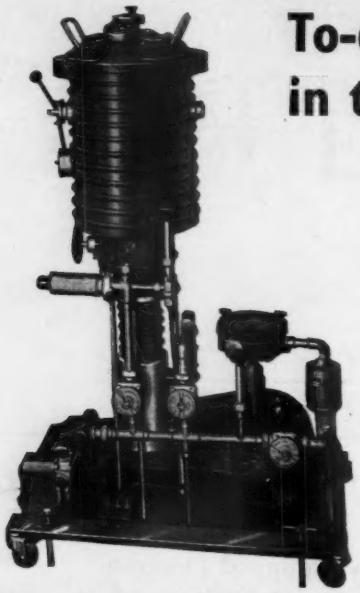

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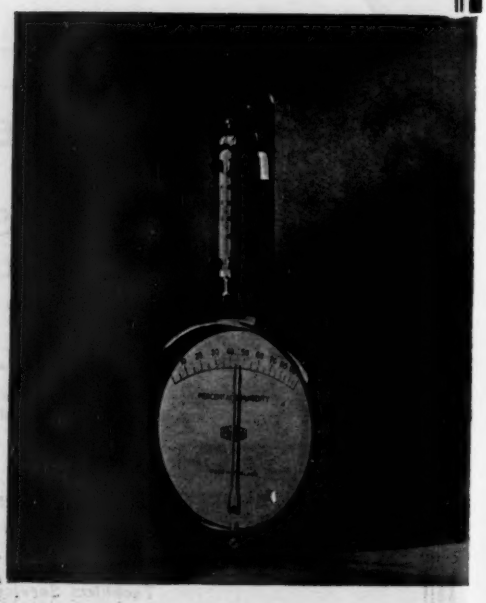

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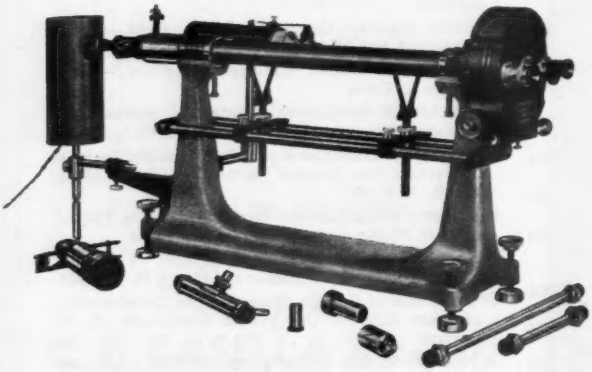

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TRANSPORT, FUEL AND ELECTRIC POWER IN BRITAIN

THE Transport (Railway Finances) Bill, the second reading of which was moved by the then Minister of Transport and Civil Aviation, Mr. Harold Watkinson, in the House of Commons on December 3, is intended to implement the recommendations of the British Transport Commission in the White Paper containing proposals for modernization of the railways. These proposals contemplated that the Commission could be self-supporting in about five or six years, if the modernization of the railways was accelerated, services were improved, productivity increased and the railways' greater freedom to charge competitive rates was used. Stress was laid in the White Paper on the progress made with multiple-unit diesel trains, and Mr. Watkinson referred to instances where receipts from the introduction of such trains had risen not by the 30 per cent or 164 per cent quoted in the White Paper, but by 90 per cent and 238 per cent.

This particular aspect of modernization of railways in Britain has been threatened by the interruption to oil supplies due to the closing of the Suez Canal. While, however, it is unlikely that until the Canal is cleared the flow of oil into Europe will exceed 70 per cent of the previous volume, the economic and practical arguments for the use of diesel motive power on railways in Britain are soundly based, and neither this development nor the increasing use of oil by steel works should be interrupted on that account. What is important is that developments should be planned and encouraged not piecemeal but in relation to the needs and resources of Britain as a whole.

Clearly, while the rationing of petrol continues, much traffic will go by rail which normally would go by road, and it is admittedly the hope of the British Transport Commission to retain some of this traffic. It is true, moreover, that some heavy and long-distance traffic goes by road in normal conditions, whereas it would be in the national interest to send it by rail; but as was pointed out in the debate on December 3, the diversion of traffic from road to rail and vice versa can have serious repercussions, and these may not always be in the national interest. Mr. F. McLeary, while admitting that the introduction of diesel train services in certain areas would offer great advantages both from the point of view of railway economy and of the travelling public, pointed out that 60 per cent of road passenger routes and 40 per cent of the mileage were run at a loss. Unrestricted competition could clearly lead to a very difficult position.

From many points of view rail and road transport require consideration as one problem; and it is not only in respect of the demands they make on a scarce resource such as oil that they need to be considered from a national point of view. The Government indeed has already, through the high level of taxation imposed on road transport, even before the recent increase in the tax on petrol, assumed a large responsibility for the direction or diversion of transport as between road and rail, and the debates on the Hydrocarbon Oil Duties Bill have emphasized the extent to which the cost and efficiency of transport affect every side of the industrial, agricultural and commercial life of Britain. This may well have been under-estimated by the Government; but apart altogether from that effect, the petrol shortage gives greater urgency to the road development programme and to every reasonable method of increasing the efficiency of road transport.

It is not simply that there is much room for greater efficiency and economy in the use of petrol by both public and private transport. The inadequacy of the road system of Britain to the transport it has to carry is the cause of much inefficiency and much waste of petrol. We have already the highest density of road traffic of any major country, but are none the less the only important European country which has not recognized the need and value of good roads and embarked on an adequate programme of road construction. The elimination through rationing and the increased tax of much of the less-essential traffic may well, by reducing congestion and traffic blocks, increase the efficiency with which petrol is used by the essential traffic and lead to savings in petrol as well as in time.

We have now been forced in rationing to make a distinction between traffic of economic priority and other traffic, as was urged in the first of two broadsheets on "Solving Traffic Problems", issued by Political and Economic Planning, and to recognize that there is a limit to the extent to which private motor-cars can be used in the central areas of cities in their present form, especially for journeys to and from work. We have not yet, however, attempted to achieve a proper balance between private and public transport, and still less any co-ordination between rail and motor transport. Country districts, for example, abound in examples of what appears to be a deliberate neglect of any attempt to suit bus time-tables to the needs of rail passengers. Still less have we begun to relate transport needs to the use of land, and to co-ordinate the planning of the use of land with the planning of transport facilities.

The present period of petrol rationing does, in fact, give an opportunity for a very useful stock-taking, and for giving pause to some practices we can ill afford. It underlies, for example, the importance of what, in the second broadsheet, Political and Economic Planning concludes is the first essential in a road transport plan for Britain—a clear definition of what is meant by traffic needs. We cannot contemplate road reconstruction on a scale necessary to meet the potential traffic desires in central areas, and the long-term solution of congestion lies in reducing the amount of retailing and office employment in central areas and in the careful location of large concentrations of new industry.

PEP then suggests that present plans and projects, including the '*A*' ring motor-way project for London, require re-examination in the light of more adequate data. Sir Charles Goodeve was even more forthright on this point in his recent Henry Spurrier Memorial Lecture when he urged the use of operational research on various subjects relating to roads. There is much work to be done here, not simply by the Road Research Laboratory, the Ministry of Transport Unit and by the Unit maintained by the Metropolitan Police, but also in those departments in the Universities of Durham, Birmingham and London which have already begun to investigate traffic engineering.

Next, Political and Economic Planning looks to new underground railways as a much better investment than urban motor-ways in areas of high land value, such as central London, and concludes that the advantage to be gained for passenger carrying is so great that there is a strong case for meeting the cost from public funds. Again the urgent need is stressed for greater co-ordination in planning road and rail facilities and the use of land in the conurbations, especially London, and also for a radical overhaul of administrative methods in the management of traffic. The problem of urban traffic, it is suggested, must be dealt with by regulation, by the provision and improvement of channels of movement —by road and rail—and by planning control, all of which fall within the scope of the science of traffic engineering hitherto so neglected in Britain. Political and Economic Planning also believes that there is considerable scope, in London and other cities, for measures such as the extension of one-way streets, which improve the street capacity and in the long run reduce accidents. Such measures could make many existing plans for improvement superfluous. Parking capacity in a central area, too, must be in balance with street capacity into and out of the area, while finally the broadsheet gives its support to 'rationing by price' as the easiest means of regulating street parking and private car traffic generally in central London. Subsidized all-day parking is not in the public interest.

Some of these points were also made in the debate on the road reconstruction programme which Lord Lucas of Chilworth initiated in the House of Lords on December 19. Lord Lucas emphasized first the inadequacy of the road system of Britain and, secondly, the lack of a sense of urgency in prosecuting a programme of development. While the number of motor vehicles on the roads in 1956 was more than double that in 1939, the total expenditure on roads when the programme was at its peak would, in terms of money, be less than was spent thirty years ago. The actual expenditure on major improvements and new road construction in Britain during the three years 1954–55 to 1956–57 was only £29 million, although further expenditure of £30 million in 1957–58 and £42 million in 1958–59 was projected. Lord Lucas claimed that because of our antiquated road system, the petrol consumption of the country is almost double what it need be. Lord Latham also emphasized the waste of petrol due to circuitous routes and bottlenecks; he urged that the availability of man-power and materials rather than finance should be the determining factor in expenditure on roads, and quoted Sir George Burt's opinion, as president of the Federation of Civil Engineering Contractors in February 1955, that the industry could construct the 800 miles of new motor-ways needed without undue strain on its resources.

While there was some difference of opinion as to whether the construction of new trunk roads or the maintenance and improvement of existing roads is the more urgent need, there was strong support for more objective inquiry, such as Sir Charles Goodeve advocated, on which to base a road reconstruction programme. Lord Stonehaven suggested that the Road Research Laboratory should be encouraged to conduct a comprehensive survey of traffic conditions. Lord Selkirk, replying for the Government, also welcomed Lord Ferrer's suggestions for factual inquiry into the cost of providing an adequate road system and the probable savings that would result in the running costs of vehicles; but he claimed that, including maintenance, we are already spending £100 million a year on the roads of Britain. He added that our present programme is concentrating on trunk and Class I roads, and although he did not say that the country must be prepared to make the sacrifices which the tremendous investment requires, he gave an absolute assurance that, within the strength of the economy, the programme would proceed and expand.

Even more than this debate in the House of Lords, the debate on the Electricity Bill set the question of fuel and power in its wider context. The Minister of Fuel and Power, Mr. Aubrey Jones, in answering a question on December 17, had said that, while no firm estimate of additional supplies of oil from overseas sources to Europe or of their cost could be made pending completion of the inquiry being conducted by the Organization for European Economic Co-operation, it was improbable that the level could exceed 75 per cent of the normal in the next two months. In moving the second reading of the Bill, which constitutes the generation and bulk transmission of electricity as a separate function, responsibility for which is entrusted to a generating board appointed by the Minister, Mr. Jones had added that it is intended that the generating board should concentrate on the nuclear power stations.

Mr. Geoffrey Lloyd, a former Minister of Fuel and Power, in stressing the importance of the Bill, went so far as to suggest that it was really concerned with the establishment of an organization mainly for the promotion and distribution of nuclear power. Mr. Lloyd, it will be recalled, appointed the Herbert Committee, one of the recommendations of which was the treatment of generation and bulk transmission of electricity as a separate unit. Moreover, while Mr. Lloyd agreed that the cost of expanding the nuclear energy programme is bound to be heavy and the trebled programme would probably require an expenditure over the next nine years of £700 million–£720 million compared with the £350 million which the construction of ordinary power stations would require, he pointed out that the

annual expenditure would be only about 1·5 per cent of the gross capital formation last year. Furthermore, when we reached the stage when nuclear power began to displace other forms of fuel and power, we should approach a point when the load factor would become of critical importance. Nuclear power stations, in view of their high capital and low fuel costs, must be operated continuously day and night, and it was at this stage that the Electricity Council recommended by the Herbert Committee could be of real importance to Britain.

Mr. Lloyd referred, for example, to the possibilities in regard to electric storage heaters, as well as to the operation of automatic plant; but although he urged that we should be considering these possibilities and preparing for them, he recognized that this was a long-term policy, and that as Mr. A. Albu and Sir Ian Horobin even more explicitly pointed out, nuclear energy could make no appreciable difference to the oil position of Britain in the next ten years. Even if the output of the stations was doubled and the output of coal was maintained, the estimated saving of about 7·5 per cent of the present oil consumption might well be exceeded by increasing demand. Over the next ten years, dependence on oil is likely to increase, and it is unlikely that Britain will be able to reduce its dependence on imported oil until after 1965. Thereafter, nuclear power should progressively reduce the damage which an interruption of oil supply could do to the economy of the country.

Sir Ian Horobin frankly advocated that if the choice had to be made, it would be wiser to reduce the allocation of resources to the coal industry and put that sum into the nuclear power programme. The Parliamentary Secretary to the Ministry, Mr. D. L. M. Renton, replying to the debate, commented that even if the nuclear energy programme were expanded, we should still need all the coal we could produce as well as very large quantities of oil. He agreed that it is the duty of the Government and of Parliament to see that the electricity supply is organized in the best possible way to take the earliest advantage of the coming of nuclear power; but neither he nor other speakers in the debate emphasized, as was done in the House of Lords debate, the vital importance over the next decade of eliminating all possible sources of waste of energy of any kind.

Mr. Geoffrey Lloyd's reference in the debate to the value of the research that had been carried out on the re-design of boiler plant to permit the consumption of low-grade fuel indicates that at least some in Government circles appreciate that the problem of fuel and energy is one, and the use of such resources should be approached as a whole. The Electricity Bill, following the recommendation of the Herbert Committee that one board, free to utilize any source of energy, should be wholly concerned with the generation and transmission of electricity, is a step in the right direction. We need now to consider how far we can proceed in the further integration of the production and use of gas, coal, electricity and oil and the economies that are possible in this way.

Clearly, as was hinted in the debate on December 17, there are immense possibilities, though to achieve them a considerable investment in research is still required, much of which would be of a fundamental and long-range character. Meanwhile something could be done to eliminate the waste of fuel both in industry, on the roads and in domestic heating. The Government has still far to go to implement effectively the recommendations of authoritative committees in these matters, and technologists have ample scope to urge on Parliament by all means in their power the vital importance both of attacking the problem of the production and use of fuel and energy as a whole, and of dealing with the problem of fuel efficiency and the elimination of waste at its roots. There are few fields in which the application of scientific knowledge could do more to strengthen Britain's economy, and few in which existing knowledge is more widely neglected by the State, in industry and in the home.

RELATIVITY AND THE EXPANDING UNIVERSE

General Relativity and Cosmology

By Prof. G. C. McVittie. (International Astrophysics Series, Vol. 4.) Pp. x+198. (London: Chapman and Hall, Ltd., 1956.) 42*s*. net.

Expanding Universes

By Prof. E. Schrödinger. Pp. viii+93. (Cambridge: At the University Press, 1956.) 17*s*. 6*d*. net.

ALTHOUGH both these books are written primarily for the small band of mathematical relativists, each has a wider appeal. Prof. E. Schrödinger's slim volumes never fail to illuminate by originality of approach. Prof. G. C. McVittie is a master of the technique of general relativity, and the most original feature of his latest book is his fascinating application of that technique to the solution of problems in classical gas dynamics.

Prof. McVittie prefaces his book by some very timely remarks on the function of general relativity, arguing that this method has nothing significant to say in the realm of electromagnetism, where it would appear that quantum mechanics is the appropriate weapon. Instead, it is best regarded as "a generalization and, at the same time, an amalgamation, of Newtonian gravitation and hydrodynamics and therefore as a theory of mechanics dealing with the phenomena manifested by matter in bulk".

McVittie's introductory chapter goes, however, much further than this and is, in fact, a methodological manifesto of considerable interest in itself. It is a very forceful statement of the point of view which was neatly epitomized many years ago by J. J. Thomson in the famous epigram that a scientific theory is a policy (or tool) and not a creed. This is a particularly challenging attitude for McVittie to adopt for two reasons—one general and the other specific. On general grounds, it has recently been argued with characteristic brilliance and lucidity by K. R. Popper in his contribution to the recent volume on "Contemporary British Philosophy" (edited by H. D. Lewis. Allen and Unwin, 1956) that the view sponsored by Thomson (although he does not mention his name) which he calls 'instrumentalism' is

obscurantist and cannot account for scientific progress, for "In contrast to the highly critical attitude requisite in the pure scientist, the attitude of instrumentalism is one of complacency at the success of applications". This is a proposition which could be argued at length on both sides, but McVittie's adoption of the instrumentalist point of view in relation to general relativity might be thought also to be open to challenge on more specific grounds. For it has generally come to be accepted that the peculiar appeal of general relativity is primarily æsthetic and rational rather than in virtue of its power of application, apart from the 'one-body problem'. The incentive to develop alternatives to general relativity has come mainly from the widespread feeling that, despite its formal beauty and generality, the technique is unwieldy and its physical significance often obscure. McVittie, on the contrary, is an enthusiast for the theory, but he is not content merely to argue in general terms that the theory is as powerful as it is elegant. Instead, he has made a welcome and determined effort to justify his view by practical application.

His book falls into three main divisions. In Chapters 2 to 5 he gives a workmanlike exposition of the tensor technique and its application to Riemannian geometry, a brief summary of Newtonian mechanics and of special relativity, the principles of general relativity and Schwarzschild space-time. The exposition is terse and to the point, and the object is to present relativity as a research tool for the mathematical physicist. It should be mentioned that the discussion of the empirical testing of Einstein's theory is unusually thorough for a text-book of this kind.

The second section of the book is devoted to a study of approximations to Einstein's equations which goes deeper than previous studies by other investigators. McVittie's analysis yields as an important by-product an original method for the solution of the equations of classical gas-dynamics. The key to the success of the method is the fact that the relativity constant $\varkappa = 8\pi G/c^2$, where G is the constant of gravitation and c the velocity of light, is very small, being of the order 10^{-27} in the c.g.s. system of units. McVittie establishes the general theorem that the distribution of matter corresponding to an orthogonal static metric, the coefficients of which differ from those of the Minkowski metric by terms of order $\varkappa$, is at rest in the co-ordinate system and its pressure is constant to the first order in $\varkappa$. From this he deduces that, to the first approximation in $\varkappa$, the Newtonian approximations to the solutions of Einstein's equations give the hydrodynamical motions of a compressible perfect fluid, the only force being the pressure-gradient; the second approximation in $\varkappa$ introduces the self-gravitation of the fluid. McVittie then uses these results to obtain a systematic classification of gas motions in Newtonian theory.

The last two chapters of the book are devoted to a very thorough discussion of theoretical cosmology, based on general relativity, and the presentation of theoretical formulæ in a form suitable for numerical computation as and when fuller observational data become available. These chapters are likely to become standard sources of reference for this purpose.

Prof. Schrödinger's book is much more restricted in its scope than Prof. McVittie's. Its title is somewhat misleading as he is not concerned with a systematic investigation of expanding world-models. Nearly half the book is devoted to the geometry of the de Sitter model which, because its matter-tensor vanishes, allows a bewildering variety of representations, so that, in the author's view, it is hard to grasp the identity of the underlying geometrical object. The various representations (spherically closed or flat and infinite, expanding or static) are, however, not all strictly alternatives, because they do not each comprise the same basic object; the static frame, for example, confining the world to a comparatively small section of it. This restriction entails paradoxical consequences concerning moving bodies apparently entering and leaving the universe within a finite span of their proper time and also concerning light-signals reaching the observer from events to which he is unable to assign any real value of the time co-ordinate. Schrödinger's very thorough discussion of these representations and anomalies is illuminated by several careful drawings by Mr. Alfred Schulhof.

The second half of Schrödinger's book is less entertaining but perhaps more valuable. After a discussion of light-rays, paths of free particles, and general frequency-shifts in general expanding space, he examines waves in general Riemannian space-time and in an expanding universe. The central problem concerns the changing configuration of a wave-group of (nearly) monochromatic waves, proceeding in (nearly) one direction, due to the expansion of the space. The author develops a method of determining all the proper vibrations of the expanding universe and concludes that all wave-lengths expand at the same rate as the radius of space.

Both books are admirably printed and produced and can be strongly recommended both to specialist students and to others who are not deterred by the sight of mathematical methods and symbolism.

G. J. Whitrow

SILICIC SCIENCE

Silicic Science

A Review of the Colloid Scientific Properties and Phenomena exhibited by Matter composed essentially of the Element Silicon. By Prof. Ernst A. Hauser. Pp. xii + 188 + 27 plates. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1955.) 37s. 6d. net.

THIS book is based on Prof. Hauser's lectures at the Massachusetts Institute of Technology on "The Colloid Science of Silicon". As Prof. Weyl says in his introduction, he "picks at random those fields which are most neglected in text books". Inevitably, therefore, the book gives something of the impression of a rag-bag. It brings together two fields of study which have tended to remain apart from each other: on one hand, the chemistry of the silanes, silicon-organic compounds and silicones; on the other, chemical and colloidal studies of clays.

It seems to the reviewer that the book would have gained if Prof. Hauser had eschewed all notion of being complete. In one chapter, for example, he treats base exchange, differential thermal analysis, infra-red analysis and X-ray diffraction in five text pages.

There is a non-mathematical discussion of colloidal phenomena in silicic science, in which extensive use is made of Hamaker's idea of potential curves. Little is said about the development of this idea by Verwey

and Overbeek, and Derjaguin is not mentioned. Another chapter treats the atomic structure of glass, with extensive quotations from Weyl's papers on the subject. A chapter on reactions of bentonite with organic compounds discusses the formation of the organophilic clays known as 'bentones'. The reviewer was interested to read here of experiments on the possibility of forming clay esters carried out at the Massachusetts Institute of Technology by Bart and Gusman, and later Bralove, experiments which do not seem to have been published (the upshot of them is negative). Deuel's work is noted in the bibliography, but not discussed; other important papers by Berger, Greene-Kelly, Brown and Norrish, and Martin Vivaldi and Hendricks are omitted.

A final chapter contains interesting brief discussions of a series of applications with which the author has been concerned; ceramics, catalysis, agriculture, bentonite films and plastics, drilling fluids, water softening, thixotropic rubber compounds, pharmaceutics, 'bentones' and silicones. There are also chapters on silicic acid, membrane equilibrium and related topics, ultra- and electron-microscopy, rhythmic precipitation, soil stabilization and silicones.

The reviewer would not care to recommend this book to students, because of its unsystematic character, and because the author is inclined to brush aside theories he dislikes, and insinuate unorthodox opinions without fair warning. Specialists in clay studies will be interested to read Prof. Hauser's ideas, drawn from a wide and long experience, especially with regard to practical applications.

D. M. C. MacEwan

LIFE OF THE SWIFT

Swifts in a Tower

By Dr. David Lack. Pp. 239+19 plates. (London: Methuen and Co., Ltd., 1956.) 21*s*. net.

THIS is a compact book written in non-technical language and felicitous style, with frequent incidental recognition of human values and many references to general literature. Yet it is rigorously scientific in its treatment of the subject, full of original observation and with critical appraisal of earlier publications. One would not need to be an ornithologist to enjoy this account of a most remarkable bird, and of the methods used for making its close acquaintance. To the ornithologist it is a fascinating addition to knowledge of a species at once familiar and in its habits little described since the time of Gilbert White.

The British swift, with its kindred elsewhere, is the most aerial of birds—to be seen at any time during four months of summer, but usually just as a fast-moving object and often high above us. Yet it is not impossible to observe accurately under these conditions, whether it be feeding on flying insects at 25 miles per hour or making a spectacular dash at more than twice that speed; whether it be gathering nest material in mid-air or sipping water without alighting on the surface: it has been seen, by Dr. David Lack among others, to mate in flight, and there is substantial evidence that it often spends the night on the wing. Its migrations are diurnal and have repaid observation.

The domestic life of the swift on the other hand, was until lately almost unknown, because it nests in holes which are commonly inaccessible, on high buildings, and often too far into these to be reached in any event. This book, however, describes ten years of observation of nesting swifts 'from inside'. The opportunity was offered by the colony in the ventilation holes in the tower of the University Museum at Oxford (associated in memory with the historic debate on evolution between Huxley and Wilberforce); it was ingeniously taken, by the insertion of nesting boxes with lids and glass panels which made it possible to study the birds at the closest quarters from within the tower. Many ornithologists and others have climbed the tall interior ladders to see the birds, which are unafraid of approach in these circumstances; but it is to many hours of patient observation by the author, and by his wife and other assistants, that we owe the wealth of information now presented in such attractive form. The results are of great interest, and are illustrated by remarkable electronic flash photographs by Mr. H. N. Southern, but no attempt to summarize them can be made in a short review.

It must suffice to say that there are chapters dealing with the fight for homes, with courtship, with nest-building, with laying and incubation, and with the nestlings in their naked and feathered stages. Other chapters deal with the swift at large—its feeding habits, its flight and its migration. Then there is a statistical chapter on the birth-rate of swifts; and finally a philosophical chapter on the meaning of adaptation, a theme for which the extreme specialization of the swift provides an appropriate basis.

The British swift is but one of some seventy species, the majority of which live in the tropics, while the others are long-distance migrants exploiting the transient wealth of insect-life in temperate latitudes. The author makes frequent reference to what is known about the foreign species, and he touches on the taxonomy of the group. He pays tribute to the work of Mr. E. Weitnauer, who had earlier begun a similar study of the alpine swift—a larger and pale-bellied congener—in the tower of a village church in the Jura Mountains.

Landsborough Thomson

RESONANCE AND VALENCE

Resonance in Organic Chemistry

By Prof. George Willard Wheland. Pp. xiii+846. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 120*s*. net.

THE idea that molecules, particularly organic aromatic molecules, may be conveniently described in terms of quantum-mechanical resonance between several valence-bond structures was developed in the early 1930's mainly by Slater, Hückel and Pauling, after it had been foreshadowed in 1926 by Ingold's theory of mesomerism. Since that time the theory of resonance has been widely applied by organic chemists to provide a theoretical basis for an understanding of the structure and reactions of organic molecules. Unfortunately, there has not been such a wide understanding of the basic ideas of the theory nor a sufficient appreciation of its limitations. Consequently there are to be found in the literature and in text-books a number of incorrect, or at least misleading, expositions of the theory and many examples of its misapplication. Prof. Wheland shows, for example, that recent criticisms of the theory of resonance by Russian authors are based on

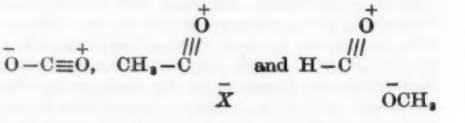
an incorrect interpretation of the theory, and he states: "It therefore appears that, like a number of other people in the United States, as well as abroad, these authors have been misled by carelessly worded expositions of the theory, which give an erroneous impression of its physical meaning and which are unfortunately all too common".

Prof. Wheland has long been an exponent of the theory of resonance and of its usefulness in organic chemistry. He has in this book considerably revised and enlarged his earlier work, "The Theory of Resonance and its Applications to Organic Chemistry", that was published twelve years ago. The main plan of the book follows that of the earlier work, and in making the revision Prof. Wheland has attempted to provide a qualitative, yet detailed, exact and thorough treatment of the theory, and of its application to organic chemistry, at the same time avoiding any statements that might be misleading or which might give rise to erroneous interpretations of the theory. It may be said at once that he has succeeded admirably. In addition the present book contains a new long chapter on the mathematical basis of resonance, and a very considerably enlarged appendix giving interatomic distances and bond angles in organic molecules, which attempts to be complete up to July 1954.

The first two chapters on the theory of resonance and the nature of valence discuss qualitatively the basic ideas, assumptions and limitations of the resonance theory. They are exceptionally clearly written, and all the fundamental ideas and terminology are explained with great care. A brief discussion of the molecular orbital theory is introduced in Chapter 2, which is, however, neither so clearly written nor so thorough as the preceding discussion of the resonance theory, and scarcely enables the reader to make a fair comparison of the two methods. No use of the molecular orbital theory is made in later parts of the book and this discussion could well have been omitted without loss.

The chapter on resonance energy is admirable. It sets out very clearly all the assumptions and difficulties involved in the determination and comparison of the resonance energies of molecules. The explanation that the resonance energy of carbon dioxide arises largely from resonance between two structures, both of which are represented by the conventional diagram O=C=O, and similar discussions of the *iso*cyanates and *iso*cyanides, are made unnecessarily difficult to follow by the absence of any figures showing the arrangement in space of the relevant atomic orbitals.

Prof. Wheland has largely succeeded in avoiding a not uncommon tendency to attempt to explain the properties of molecules and their reactions solely in terms of the resonance theory, thus neglecting other, often equally important, factors. Thus, in the chapter on steric effects of resonance his treatment of interatomic distance is generally a fair and balanced one and consideration is given to other factors that are of importance. In discussing the effect of resonance on the inter-atomic distance between two atoms it is first necessary to assign values to the 'pure' single and double bonds between these atoms. This is admittedly a matter of some difficulty, but to take the C=O double bond length as 1·24 A., as in acetone and formaldehyde, is surely incorrect, since there must be resonance in these cases between the structures C=O and $\overset{+}{\text{C}}-\overset{-}{\text{O}}$. This leads to difficulties in considering the length of the C=O bond in molecules such as CO_2, CH_3COX, and $HCOOCH_3$, for which resonance structures such as



have to be postulated in order to explain the 'short' C=O bond lengths observed in these molecules. If, as seems more reasonable, it is assumed that the C=O bond length is close to that in CO_2 (that is, 1·16 A.) these difficulties can be avoided.

Although Prof. Wheland has taken great care to avoid misleading the reader concerning the significance of resonance, he has not been quite so successful in his, admittedly brief, discussion of hybrid orbitals. Thus, for example, he states (p. 210) that "the orbitals of a carbon atom that form four bonds are necessarily hybridized". This, however, is not strictly correct. It is only necessary that these orbitals should be hybrid orbitals if one wishes, as is usual, to describe a molecule in terms of only one valence bond structure. A molecule can, however, be equally correctly described in terms of resonance between a number of structures or pairing schemes, each of which makes use of atomic orbitals only.

The chapters on resonance and chemical equilibrium and resonance and chemical reactions occupy 200 pages and include a useful and critical discussion in terms of the resonance theory of a large amount of recent work on the strengths of acids and bases, the stability of free radicals, and the mechanisms of organic reactions.

The final chapter, on the mathematical basis of resonance, occupies 150 pages and constitutes by itself an excellent introduction to quantum mechanics. It is not such easy reading as the earlier part of the book, but it well repays a careful study. It discusses clearly and thoroughly many concepts that are often found difficult when they are met for the first time, and which are generally not treated so fully in other books. Thus, for example, there is a very clearly written discussion of the ideas of paired and unpaired electrons, parallel and anti-parallel spins, and singlet and triplet states. It gives a very full discussion of the exact meaning of the terms resonance hybrid, resonance energy, and resonance frequency. The concept of resonance frequency, which has often been misunderstood, is particularly well discussed. The second half of this chapter is concerned with the quantitative application of the valence bond and molecular orbital theories to aromatic molecules, and it explains clearly the assumptions and somewhat drastic approximations that have to be made.

The few criticisms that have been made above are all relatively minor ones and it may be said that the book is an altogether brilliant and masterly survey of the theory of resonance and its applications to organic chemistry. It will undoubtedly remain for many years the standard work of reference for all organic chemists and many others who are interested in the theory of resonance and in its applications to organic chemistry. The printing and production of the book are excellent, and very few misprints were noticed. It is only to be regretted that the very high price will put it beyond the reach of students and of most of their teachers.

R. J. Gillespie

Tables of Physical and Chemical Constants and some Mathematical Functions

Originally compiled by Dr. G. W. C. Kaye and Dr. T. H. Laby, now prepared under the direction of an Editorial Committee. Eleventh edition. Pp. vi+233. (London and New York: Longmans, Green and Co., Ltd., 1956.) 25*s*. net.

SINCE its inception in 1911, "Kaye and Laby" has been a household word among physicists and chemists, and though the link with the original authors is now severed—for Prof. Laby died during the printing of the tenth edition and Dr. Kaye while the ninth was being prepared—the tradition of the book is being well and truly maintained. This new eleventh edition is the work of an editorial board consisting of Prof. N. Feather (University of Edinburgh) as chairman, with Dr. H. Barrell (National Physical Laboratory, Teddington), Dr. E. A. Coulson (Chemical Research Laboratory, Teddington) and Mr. J. M. C. Scott (University of Cambridge) as the other members.

It is eight years since the tenth edition was published, and during this time both a great deal of new territory in the physical sciences has been discovered and also—and just as important—much of the ground that had been previously explored has been more thoroughly charted and consolidated. As a result, the compilation of new data and the revision of old material have been heavy, and thirty-eight contributors are listed as having had a hand in the present edition. Although much in detail has been altered, the essential features of "Kaye and Laby" remain as before. By a rigorous application to their task, the editors have succeeded in avoiding the obvious pitfall of allowing the volume to get out of hand in content and size, and, in fact, this edition is no larger than the previous one.

The book is divided into four sections, the first of which, on general physics, takes up nearly half the space (108 pages). Then follow the sections on chemistry (65 pages), atomic physics (35 pages) and four-figure mathematical tables (17 pages). Finally comes the index of seven pages; this last-named is most important because, since there are no contents pages, the only way of finding a particular item rapidly is to look it up in the index.

Physical Properties of Wool Fibres and Fabrics

(Wool Research, Volume 2.) Edited by H. Lemon. Pp. vi+234. (Headingley, Leeds: Wool Industries Research Association, 1955.) 30*s*.

THE understanding and development of technological processes in the wool textile industry have been materially assisted in the last three decades by the Wool Industries Research Association. The present book is a summary of the research so far carried out at Torridon on the physical properties of wool fibres and fabrics. It does not describe work carried out to elucidate the structure of the fibre, but treats the measured physical properties of wool and relates them to its functional behaviour and to certain processes in textile technology.

Thus a large section of the book is given to a consideration of wool and water vapour relations, which have practical applications in such widely divergent fields as commercial testing for weight, the drying of fibre assemblies, and the design of clothing. This is followed by a section on the warmth of clothing which sets out the physics of the air-flow and heat transfer through fabrics, and also the relevance of the elastic properties of the fibre in maintaining the optimum fabric structures for warmth.

The mechanism of the water repellency of wool fabrics and feathers is discussed thoroughly—this has relevance in the design both of rainproof fabrics and of laboratory tests for their appraisal. The peculiar frictional properties of wool are discussed very fully—this is a very interesting chapter which summarizes all the work done in this field.

Physicists outside the textile industry will be interested in this chapter and that on the electrical properties of wool, in which fields notable contributions to basic physics have come from workers in technological foundations.

The selection of material is confined to those fields in which the Wool Industries Research Association has itself worked, and in some cases, in particular the chapter on elastic and plastic properties, is restricted to its own contributions. However, physicists and engineers interested in the properties of matter will find this book a stimulating introduction to some first-class work which has been published in many scattered journals.

The book is intended mainly for readers in industry and makes little demand upon mathematical skill. The presentation is generally clear and the book is very well illustrated. W. J. ONIONS

Ciba Foundation Symposium

Jointly with the Physiological Society and the British Pharmacological Society, on Histamine, in honour of Sir Henry Dale. Edited by G. E. W. Wolstenholme and Cecilia M. O'Connor. Pp. xvi+472. (London: J. and A. Churchill, Ltd., 1956.) 50*s*. net.

THIS volume, in fact, contains the proceedings of two symposia on histamine. The first symposium, which was held in public at the Wellcome Institute, London, consisted mainly of formal papers which occupy about two-thirds of the book. The second, sponsored by the Ciba Foundation, was a private gathering in London of scientific men specially interested in histamine who met in honour of Sir Henry Dale and to talk about histamine. The recorded discussions of this symposium are a valuable feature of the book and repay careful study.

The subjects dealt with in the two symposia cover more or less the same ground. All the important advances of the past ten years are reviewed, and there is a wealth of bibliography. The new techniques, tracers and chromatography, in particular, have certainly yielded a plentiful harvest. Of outstanding interest are the new facts on the origin and fate of histamine in the body. For example, when isotopically labelled histidine is injected into an animal, some of it is converted into labelled histamine, presumably by decarboxylation. Histamine from this source forms a separate pool inside the cells, since it does not exchange with histamine injected into the body. It can, however, be released from the cells by a wide range of substances which contain basic groups. Once histamine has left the cell, it undergoes a rapid degradation and the various metabolites formed can be estimated in the urine. This is only one of many other fascinating contributions on the distribution of histamine in the body, its location in cells, the mode of its release by substances of known structure, its possible role in gastric secretion and on its curious association with heparin in mast cells.

For those who are interested in histamine, this is in every way an exceedingly useful and stimulating book.

H. M. ADAM

THE ROCKEFELLER FOUNDATION, NEW YORK

By JOHN BEAVAN
Assistant Director, Nuffield Foundation, London

THE activities of even the wealthiest foundations have ceased to be spectacular since philanthropy became the business of national and international agencies. To-day, State and inter-State munificence dwarfs the spending of all private bodies concerned with welfare and the endowment of scholarship and research.

Nevertheless, the place of foundations in the history of the Welfare State is undisputed. They were the private pioneers of much experiment and welfare which are now done by the State itself. Indeed, the test of success foundations used to apply to their missionary efforts was whether the public authorities felt compelled to take them over and run them with public money.

But now, as Dwight MacDonald put it in his study of the Ford Foundation, the frontiers of philanthropy are closing in. Is there still a useful place for the private foundation in a State which has equipped itself with expert bodies to promote research, and has provided them with plenty of money and freedom? Indeed, many people think that the State is already doing more than it should do and it is wrong for voluntary bodies to urge it to do more.

They forget, however, that even if the State cannot expand its services, it must from time to time change its priorities. New demands have to be met, sometimes at the expense of established schemes; or established schemes have to be altered to meet new conditions. The private foundation which is free from the pressures of political and other interests is in a very good position both to search for new priorities and suggest amendments in established schemes.

Then it must be remembered that the best foundations have never confined their philanthropy to one country, and to-day they are finding more and more scope in the undeveloped countries, where they meet all the traditional problems, but in more diverse and intractable forms. A glance at the annual report of any great foundation should remove all doubt of whether it has a part to play in the modern world, and none of these reports is more convincing than that of the Rockefeller Foundation—the first great venture in world-wide philanthropy.

In many ways Rockefeller has been the model foundation, and remains so under the leadership of its present president, Dean Rusk. Certainly, all general-purpose foundations created in the past thirty years have learned from its example, and thus the historical literature of the Rockefeller Foundation is of practical value as well as being of academic interest. It is typical of the Rockefeller Foundation's insistence on excellence that these writings should be of such high quality. The monumental biography of John D. Rockefeller, the founder, was written by Prof. Allan Nevins, one of America's most distinguished historians, and the history of the Foundation was written five or six years ago by Raymond B. Fosdick, who, for twelve years, was president of the Rockefeller Foundation and was known as the best professional in the business. Mr. Fosdick has now followed up his history with a biography called "John D. Rockefeller, Junior"*.

* John D. Rockefeller, Jr.: A Portrait. By Raymond B. Fosdick. Pp. ix+477+17 plates. (New York: Harper and Brothers, 1956.) 6.50 dollars.

The origin of the Foundation, as of all scientific philanthropy, lay in the inability of a fantastically rich man to disburse his fortune as conscience told him he must do, without getting overwhelmed. It was essential to systematize both the distribution itself and the principles on which the gifts must be made. Rockefeller was, of course, merely one of a group of Americans who at the turn of the century, the culmination of *laisser faire*, made huge personal fortunes and gave them away. Of this group, which included Morgan, Guggenheim, Duke, Armour and Sage, the one who voiced his views most eloquently on the right use of wealth was Andrew Carnegie: "the man who dies rich, dies disgraced", he said. Rockefeller, too, had a simple philosophy: "A man should make all he can and give all he can".

This group, says Fosdick, "acquiring their fortunes under conditions unique in the history of their country and not infrequently by methods which, if permissible at the time, no longer accord with social conscience or the requirements of law, enriched the cultural life of America with a stream of universities, foundations, institutes, libraries and endowments without parallel in any other age. Their motives were doubtless many and varied—genuine social vision, religious principle; sometimes in part a desire for social recognition or the perpetuation of a name".

Rockefeller, jun., was in at the start of his father's great venture in philanthropy, though he was not old enough to have a strong influence on the way it should develop. The real creator of the Foundation was Frederick T. Gates, who had been in the Baptist Ministry and still had a strong messianic urge. Rockefeller, sen., was a man of granite who liked to surround himself with other strong men. What was even rarer was his ability to pick men who would compensate for his own inadequacies. Rockefeller was reserved and inarticulate. Gates, who was to be his chief adviser in business and philanthropy, was aggressive and fluent and tremendously courageous. He would address Rockefeller as if he were a congregation of miserable sinners—"your fortune is rolling up, rolling up, like an avalanche", he would cry. "You must keep up with it! You must distribute it faster than it grows. If you do not it will crush you and your children and your children's children".

Gates joined Rockefeller after working with him on his first major act of philanthropy, the creation of the University of Chicago, which started as an idea for a Baptist institution of higher learning. When in 1910 Rockefeller made his final gift, he had contributed altogether 35 million dollars. But he never allowed the University to bear his name, never suggested the appointment or removal of any professor and never indicated his attitude to the views of the faculty.

The Rockefeller interest in medicine began when Gates, in 1897, read William Osler's "Principles and Practice of Medicine", a frank criticism of the retarded development of medical science. Gates's memorandum on what ought to be done for medicine appealed

to both Rockefeller and his son, and the Rockefeller Institute for Medical Research was set up in 1901 with Dr. William Welch, of Johns Hopkins University, as president. A short time afterwards Dr. Simon Flexner was made director.

Rockefeller, as was usual with him, gave the Institute a modest start, but as soon as he saw it was succeeding he invested more and more in it and eventually made it one of the great centres for medical research of the world. His principle, as in all things, was to aim at excellence and even at perfection, to get the best men and to give them the best conditions of work. Meanwhile, Rockefeller, jun., who had the strange upbringing of the son of a Puritan millionaire, began to develop the family's traditional interest in the Negro problem. He made plans for an organization that would deal in a comprehensive way with the problem of education in the South. It had to be comprehensive, for Negro education could not be promoted without an equal concern for the education of the whites. Rockefeller, sen., pledged a modest million dollars for its support, and then, having had it proved to him that it was a good thing, he added 20 million. Out of the Education Board sprung the third great benefaction, the Rockefeller Sanitary Commission, devoted to the eradication of hookworm.

By this time some of the principles of scientific philanthropy had been beaten out. Rockefeller had seen that the most useful way of spending money was to put funds at the disposal of independent boards of trustees, made up of the most experienced men he could find, and give them a free hand to select their officers and carry on their work. He himself preferred to retain a certain psychological detachment from these ventures. He refused to become a trustee of any one of them.

In spite of these vast outpourings of wealth, the fortune was still piling up. By 1910 Rockefeller was ready for his greatest venture, the creation of the Foundation. He had three extraordinary men to help him. Flexner, who was the son of a pedlar, had become a doctor after failing as a plumber. Dr. Buttrick had been a brakeman on the railways who had got his education by entering the Ministry. Dr. Rose, who had run the Sanitary Commission, was not a doctor of medicine but a philosopher from Peabody College. But it was probably Gates who had the idea of forming the Foundation when he put to Rockefeller the idea of a series of great corporate philanthropies for the promotion of scientific agriculture, the enrichment of rural life, the development of fine arts, the spreading of Christian ethics and Christian civilization throughout the world and the fostering of intelligent citizenship in the United States.

Gates, as ever, was troubled by the destiny of Rockefeller's great fortune and always thinking of the unknown and sinister possibilities it might have unless properly controlled. Rockefeller handed over to the three trustees 50 millions worth of oil shares to start the Foundation. The purposes of the trust were: "to promote the well-being and to advance the civilization of the peoples of the United States and its territories and possessions and of foreign lands; in the acquisition and dissemination of knowledge, and in the prevention and relief of suffering and the promotion of any or all of the elements of human progress".

Rockefeller, wishing to avoid the dead hand, would have made the trust deed subject to alteration at the pleasure of the U.S. Congress, believing that "the wisdom of living men will always exceed the wisdom of any man, however wise, who has long since been dead". But Congress was suspicious of trusts and would not have it. In the end the Foundation had to be incorporated in Albany.

Its policy was to take on projects too large for other agencies. The best philanthropy, said Rockefeller, involved a search for a cause, and an attempt to cure evils at their source. It excluded individual charity. It sought to evoke from the community its own recognition of the need to be met and its own will to meet it. One of the early lessons was how easy it could be for a foundation to run into political trouble. When the Rockefeller Foundation wanted to investigate industrial relations a United States Commission began to investigate whether a line could be drawn between the Foundation's philanthropic interests and Rockefeller's business interests. The Foundation decided after this that when it wished to do something outside the non-controversial areas of medicine, public health and agriculture, it would do better to make grants to other agencies and let them shoulder the responsibilities.

The medical story of the Foundation and its corporate bodies is a thrilling one. One of its successes was the drastic limitation of hookworm as a vast menace throughout the world. But this campaign had a greater significance than a useful attack on one disease. It was made the advance agent of preventive medicine. Hookworm was an anæmia-producing disease which sapped the vitality and even killed millions of people in the hot, moist regions of the world. An effective remedy had been discovered, but through ignorance and lethargy it was not being used. Rose first made a thorough survey to determine the geographical distribution of the disease. He emphasized tirelessly a principle which has become the first principle of other foundations: never to move without first getting the facts.

The second stage was a battle of publicity. Rose had to make it dramatically clear that the disease could be brought under control. A director of sanitation was appointed in eleven States with a corps of sanitary inspectors and microscopists. Through travelling dispensaries more than a quarter of a million rural homes were inspected, more than 25,000 public meetings were held and three million pieces of literature were distributed.

All this activity represented a co-operative effort between the State and County Governments on one hand and Rose's organization on the other. "An outside agency", Rose wrote, "can be helpful only in so far as it aids the States in organizing and bringing into activity their own forces".

The Sanitary Commission became part of the Foundation with the title of the International Health Board. One of its great campaigns was to tackle hookworm throughout the world, and it operated in fifty-two countries, always in co-operation with the appropriate governmental body. The slogan was "a partner but not a patron". Rose abhorred the idea of a private organization seeking either power or credit for itself.

It then seemed probable that the same pattern of attack could be successful if used on malaria. Moreover, nations might be induced by the campaign to build permanent machinery to deal with the whole problem of public health. However, it soon became clear that before malaria could be controlled there had to be a deeper knowledge of the epidemiology of

the disease, and the Foundation undertook extensive studies of the natural history of anopheline mosquitoes in many parts of the world. The International Health Division of the Foundation has also given its attention to typhus, influenza and the common cold. It is now, in fact, thirty years since the Division did a seven months study of the common cold in a village in a forest clearing of southern Alabama. The work here and in other remote spots helped to create a wider understanding of the common cold, though far greater development of techniques for the study of the virus or viruses must be made before there can be hope of immunization.

The story of yellow fever has a special chapter in Fosdick's book. No progress was made in the control of the disease until the U.S. Army Commission showed in Cuba that a mosquito transmits the disease. General Gorgas got rid of yellow fever in Havana by his measures against mosquitoes, and made possible the building of the Panama Canal by similar techniques. But the opening of the Canal aroused fears in the Far East that yellow fever might be introduced there. Gorgas was made the director of the Foundation's work for the eradication of yellow fever.

The work, however, was based on some wrong assumptions, and when the disease seemed to have almost vanished it erupted from the jungle of South America and created an epidemic in Rio de Janeiro. It was now clear beyond doubt that there were carriers other than the *aegypti* mosquito and they breed not merely in a few seed-beds but also in the tropical forests of the vast hinterland of South America and Africa. The thoroughness of the work that was now done makes an amazing story. All available forms of insect life in the jungle were collected, divided into broad groups, ground and filtered. The filtrates were inoculated into white mice and monkeys, and it was found that yellow fever virus was in several species of mosquitoes. Then 2,000 animals of the jungle, from mice to wild cats, and birds and snakes were trapped, but it was found that monkeys are the principal hosts of yellow fever. Contaminated by the *Africanus* mosquito, the monkey in turn contaminates the *simpsoni* mosquito, which relays yellow fever to man.

It was now essential to develop a vaccine—the deaths of the early laboratory workers alone made it necessary to find a method of immunization. From 1937 onwards the laboratories of the International Health Department began to produce the new vaccine on a large scale. During the Second World War nearly 40 million doses were distributed.

The Foundation's work for medical education was less spectacular but even more radical. Here the motivating force was Abraham Flexner's book on "Medical Education in the U.S. and Canada". Flexner, who had visited 155 medical schools, reported that not more than half a dozen were adequate. He was sent to Johns Hopkins, and the trip launched a Foundation programme in medical education which was to cost one hundred million dollars. The essential thing seemed to be to create clinical departments run by doctors who would give all their time to teaching, to research and to the care of the patients in the teaching hospital. It was when Flexner insisted on coming to the help of State universities as well as endowed institutions that Gates went out of the Foundation, saying that State universities were creatures of politics and subject to dictation on scientific and economic questions.

Obviously it was not possible that even this wealthy Foundation could help all medical schools. The old Rockefeller principle of building on strength would have to be used and the money amassed at strategic points. As the schools raised their teaching standards the need for trained men for both teaching and research became greater, and the National Research Council was enabled to provide a system of fellowships to assist men qualified for academic careers in medicine. The Foundation now turned to European medical education, which may have seemed rather presumptuous, for a good deal of it was superior to that of America. Nevertheless, in Britain and France, the laboratory sciences were not systematically integrated, and teaching was subordinate to practice in the life of some professors. When Dr. Richard Pearce went to London for the Foundation in 1919, he found people in the medical schools talking about the new unit system of clinical teaching which resembled the scheme being tried out in the United States. Pearce decided that University College offered the best opportunities for developing a model medical school, and the Foundation provided it with 5 million dollars. Grants were made to Cambridge for pathology, to Oxford for biochemistry and to the Welsh School of Medicine at Cardiff. The Foundation did good work, too, at Strasbourg, at Lyons, at Brussels, in Brazil, Canada, Syria, Malaya and Siam.

Later, in the 'thirties, the Foundation tried to do for psychiatry what it had done for physical medicine. But the term was always thought of as broadly inclusive, for it embraced neurology and psychology and had its fringes in the social sciences. Support for improved teaching in psychiatry was also extended to institutions in Europe, and notably in Great Britain. The moral atmosphere in which the Foundation's programme in psychiatry was created emerges in a statement by Dr. Alan Gregg: "First, Psychiatry, along with the other natural sciences, leads to a life of reason. It explains what must otherwise excite fear, disgust, superstition, anxiety, or frustration. It breaks the clinches we otherwise get into with life and all the unnecessary blind infighting".

When the Foundation was reorganized in 1928 the promotion of fundamental science became a primary concern of the Foundation. But, of course, this interest had existed long before, and of the National Research Fellowships, which had begun in 1919, they had created, it was said, "the most effective agency in the scientific development of American life and civilization". Moreover, the International Education Board had selected the natural sciences and agriculture as the two principal interests. Rose's idea was to "begin with Physics, Chemistry and Biology; locate the inspiring productive men in each of these fields; ascertain of each of these whether he would be willing to train students from other countries; if so . . . provide the equipment needed . . . provide by means of fellowship for the international migration of select students to each of these centres of inspiration and training". Rose visited fifty universities in nineteen countries in 1923, to inspect, as he called it, "ground harrowed by war and ready for new seed". The idea was to assist those institutions which could best use the money. There was no idea of dividing the assistance equally. The sole criterion was ability.

In the 'thirties the emphasis passed to biology and the application of the quantitative techniques of mathe-

matics, physics and chemistry to biological problems. In experimental biology the Trustees decided that the utilitarian must never be the yardstick; the test must be knowledge. Yet the religious impulse was still there. We find the Foundation asking: "Can we develop so sound and extensive genetics that we can hope to breed in future superior men? Can we solve the mysteries of various vitamins so that we can nurture a race sufficiently healthy and resistant? Can we rationalize human behaviour and create a new science of man?" Dr. Warren Weaver, by now head of the Natural Sciences Department, saw the century of biology as one of the great episodes in man's intellectual history.

It was Beardsley Ruml, director of the Laura Spelman Memorial, who moved the Foundation into the field of social sciences, with the argument that all who work towards the end of human welfare are embarrassed by the lack of knowledge which the social sciences must provide. It was, he said, as though engineers were at work without an adequate development of physics and chemistry. The research then being done by the universities was largely deductive and speculative, on the basis of second-hand observations. Ruml said that what was needed was to create facilities for research, to increase the number of able men working in the field and focus the grants on bringing together various disciplines of social sciences in the systematic investigation of concrete social problems.

The Institute of Human Relations, which the Memorial and the Foundation jointly financed, made a weak beginning but later made a significant contribution to psychology, anthropology and psychiatry. When the Memorial was merged with the Foundation in 1929, Ruml retired, and Edmund Day, professor of economics at Harvard, headed the Division.

Three major fields of special interest were laid out for support—international relations, economic stabilization and public administration. Efforts were made to develop the research resources in universities abroad as well as in the United States. Nuffield College and the Institute of Statistics at Oxford benefited from the Foundation. At Cambridge its funds went to the Departments of Applied Economics, and to the Economics Research Section of the University of Manchester. Willets, the new director of social sciences, was another Rockefeller official who put the emphasis on first-class men: "I would break any rule in the book", he said, "for a chance to gamble on talent".

Dr. Fosdick is one of those who are optimistic about the future of the social sciences, though he is well aware of their shortcomings. The actual construction of a genuine science of human behaviour still, he says, lies largely in the future. But the new directions in which effort is being expended do provide significant manifestations for advance. Nor has the Foundation neglected humanistic studies. It has done much for libraries and for the study of Oriental languages, for the drama, for music. It has rescued many refugee scholars from Europe (and, incidentally, greatly enriched American scholarship by so doing).

The last chapter of Fosdick's history of the Foundation deals with Foundation principles and practices. Great advantage, he says, accrues from the elastic charter which gives the trustees full responsibility for the operation of the organization and the use of funds. Money is a feeble offering without the study which will make its expenditure effective. Once grants are made to responsible groups or institutions, no degree of control over the operation of the grants should be exercised by a foundation. Every social agency, including the Foundation, carries within itself not only the seeds of possible decay but also a tendency to exalt the machinery of organization above the purpose for which the organization was intended. The proper objective of a foundation, unless created for a particularized purpose, is to prime the pump, never to act as a permanent reservoir. A foundation easily falls into the habit of frittering away its funds in an extensive series of small grants—which Gates used to call, "the iniquity of retail giving". Finally, modesty becomes foundations because the question of financial support in all circumstances requires tact and good taste.

SOIL RESEARCH IN NEW ZEALAND

THE TAITA EXPERIMENTAL STATION

By R. H. THORNTON

THE Soil Bureau of the Department of Scientific and Industrial Research, New Zealand, established in September 1952 an experimental station to provide for the study of soils under various types of vegetation on hilly land. A hill station was selected, for it is the soils of hilly and steep land of New Zealand, of which there are some 24 million acres, that offer the highest potential for increasing primary production.

The Station is at Taita, fifteen miles from Wellington, and comprises approximately two hundred acres. It consists of several steep-sided spurs abutting on the main range of high hills flanking the east of the Hutt River valley. The catchments of several small streams are enclosed by these spurs. The area is little interfered with apart from chance burning and is of low natural fertility, which will allow various parts to be brought to, and maintained at, different levels of fertility. The Station, at present mainly under forest and scrub, will consist essentially of three parts: a catchment of indigenous vegetation, a catchment of exotic (tree) vegetation and an area of grassland. The two catchments are in the centre of the Station and the area of grassland will surround them, serving an added role as a fire-break. This arrangement will provide an opportunity for studying grass and forest regimes alongside one another. The soil type, Taita silt loam, is in the moderately weathered, yellow brown earth group of soils which are directly related to 9 million acres of New Zealand, 4 million more than any other group of soils.

The catchment of indigenous vegetation, an area of approximately thirty-eight acres at present in forest

Fig. 1. The Taita Experimental Station. Biology building in the foreground, the regenerating native catchment in the background and at left centre the start of the grassed firebreak that isolates the native catchment

and scrub, will be allowed to regenerate indigenous forest. Studies are to be made on the ecology of regeneration with particular reference to the effect of fires on the vegetation. Here soil weathering and the loss of plant nutrients from soil under natural conditions will be studied. Rainfall measurements within and outside the forest will be compared with the stream outflow to find the rate of movement of water through vegetation and soil and the proportion lost through run-off and seepage. Regular sampling of rain and stream water for chemical analyses will determine the loss of nutrients, which will provide a measure of the rate of weathering. It is anticipated that, in collaboration with other soil organizations, a chain of such catchments will be formed throughout the world.

The exotic catchment of about fourteen acres is to be planted in compartments of different exotic timber trees, and studies will be made of their effects on soil in comparison with indigenous trees on neighbouring slopes. Any problems which arise can be studied in detail together with treatments.

Around the two catchments the land is being progressively cleared of scrub and replaced by grass. Areas of grassland, maintained under various levels of fertility, will enable investigations to be made on the chemical, physical and biological properties of a hill soil under a grass cover. Initial problems are associated with the establishment and maintenance of pastures on poor hill country in competition with the weed shrubs, gorse and blackberry. Fertilizer trials have shown the value of incorporating molybdenum with phosphate in obtaining grass–clover pastures on this soil type. The slow development of this class of land in the past may be found to have been due to a lack of knowledge of the importance of trace elements.

The investigations planned for the station are many and varied: examination of chemical and biological changes following the burning of scrub and its replacement by grass have been initiated; studies on soil temperature, moisture and permeability and the relationship with aspect and vegetation will be essential to investigations on run-off problems; plant and soil interactions, tree and grass litters, and associated microbiological activities; the stability of hill soils, soil loss and structure changes on slopes under the range of conditions available, are problems planned to be studied.

The main offices and laboratories of the Soil Bureau of New Zealand, at present situated in Wellington, are to be moved to Taita in the near future. For the present, temporary buildings, in addition to containing offices for the Station field-staff, and the Officer-in-Charge of Soil Surveys (North Island), contain the laboratories of the Agricultural Soil Physics Section, and the Biology Division of the Bureau. The Soil Physics Section is concerned with investigations on the general physical properties of soils, particularly structure and moisture–air relationships. Biological work at the Station includes: microbiological investigations of native and introduced grassland soils; biochemical studies on various soil processes and the organisms con-

cerned; assay of soil copper, employing the fungus *Aspergillus niger*; role of mycorrhizæ in tree nutrition, and studies of fertilizer requirements on soils employing indicator plants grown under glass-house conditions.

In the past, soil experimental stations have been designed to deal with immediate problems, and many of the more straightforward have been successfully solved. Problems are now becoming more complex as the soils are utilized more intensively; hence there is a growing need for basic knowledge to be able to assess, solve and, in some cases, anticipate problems. This new experimental station in New Zealand is designed to supply this fundamental information and so assist the agriculture and forestry of the future.

A CHALLENGE TO COLORIMETRY

THE Small Physics Theatre at the Imperial College of Science and Technology was filled to capacity on December 12, 1956, when the Physical Society Colour Group held a symposium on "Colorimetry: its Errors and Accuracy". An assessment of the reliability of colour measurements was manifestly of great interest, and many industries were represented in the audience.

The problem basically is this: On the trichromatic system of colour measurement established in 1931 by the International Commission on Illumination (C.I.E.), a surface colour can be specified by its chromaticity co-ordinates, x and y, and its luminance factor β. Direct measurement of these quantities by three-colour matching is too inaccurate for most commercial applications, since the matching of lights of markedly different spectral composition brings out individual differences of colour vision. Other methods have therefore been developed, including (*a*) a six-stimulus visual colorimeter in which an approximate spectral energy match is established and the effect of observer differences therefore reduced; (*b*) photoelectric colorimeters employing a photo-cell in conjunction with selected colour filters to give spectral sensitivity curves approximating to the three spectral distribution curves of the C.I.E. standard observer; and (*c*) photoelectric spectrophotometers in which the spectral reflexion curve is measured through the visible spectrum, and the colour specification calculated using the colour mixture data of the standard observer as tabulated by the International Commission on Illumination. Yet none of these methods is at present capable of specifying a colour to a limit of accuracy that cannot be exceeded by the remarkable capacity of the eye to discriminate between two colours of nominally the same specification, when compared side by side in a good light.

In principle, the spectrophotometric method gives the most absolute specification, since the determination of the reflexion factor at each wave-length is unaffected by the spectral sensitivity of the observer or photo-cell. Nevertheless, the accuracy of the result may be limited by the rather small amount of light that is sometimes available for measurement, and if an integrating sphere is used for increasing this amount, then a new uncertainty is introduced because the integrated reflexion may differ from the more directional reflexion employed in visual examination of the specimen. Other possible sources of error in spectrophotometry include stray light, finite slit-width, limited accuracy of photometric control or linearity of photoelectric response, and uncertainty in the specification of the white reference standard.

The magnitude of these inaccuracies was studied by circulating six coloured tiles, supplied by the British Ceramic Research Association, to a number of research laboratories where reflexion spectrophotometry is practised, and Prof. W. D. Wright (Imperial College) presented a comparison of the results to the meeting. In all, ten different instruments had been used, including five General Electric (Hardy) recording spectrophotometers and five non-recording instruments. Two of the latter employed double monochromators and three single monochromators. The tiles chosen for the test were of various colours and, more important, various surface characteristics, described as glossy, semi-matt and matt, although the polar reflexion curve of the matt tile showed a fairly broad specular component. One of the tiles had a very low reflexion (of the order of 1 per cent) in the green part of the spectrum and it was a tribute to the sensitivity of modern photoelectric devices that in this case the differences in the results from one instrument to another were generally less than 0·1 per cent in reflexion. For the other tiles, the reflexion of which ranged from about 20 to 80 per cent, the spread was of the order of 1 or 2 per cent.

It was noted that for five of the tiles, the average readings with General Electric recording spectrophotometers were 0·5–1 per cent lower than the average of the non-recording instruments, and this difference was attributed to the inclusion in the integrating spheres of the light diffusely reflected at large angles to the normal, whereas the non-recording instruments collected the light within a fairly narrow cone centred around the normal to the surface or, in the case of a Beckman spectrophotometer, in an annular cone at 45° to the normal. On the other hand, in the case of the so-called matt tile, the General Electric spectrophotometer readings were some 2 per cent higher, apparently due to the inclusion of some of the broad specular component mentioned above, in spite of the insertion in the integrating sphere of the black cap intended to absorb the specular reflexion. Some of the other differences could be traced to errors in the values for the reference white against which the tiles were compared. The ultimate standard is, by definition, a white magnesium oxide surface, but the discussion revealed some divergence of practice in the preparation of such a surface exactly to specification

On the assumption that the average values from the five non-recording instruments were the most nearly correct, the measurements made at the National Physical Laboratory using a Müller–Hilger 'Uvisir' double monochromator were the most accurate, with the results from the Paint Research Station using a Beckman spectrophotometer a close second. While the agreement among the different instruments was regarded by the instrumentalists at the meeting as quite gratifying, the practical colour

men made it clear that they needed something a good deal better.

The requirements in industry were discussed in a paper by Miss D. L. Tilleard, who described experiments carried out at the Paint Research Station on a set of nearly identical panels prepared by the progressive addition to a standard paint of small amounts of tinting paints of different colours. The panels were measured on the Beckman spectrophotometer and were also compared by experienced observers, under good conditions of daylight illumination, with the panels touching on a long contact line. Under these good viewing conditions, chromaticity differences of 0·0003 or even less could be distinguished in a light biscuit series of panels and differences of less than 0·01 in luminance factor. Commercial tolerances for close matching are larger than this, but may still be as small as 0·001 in chromaticity. This compares with a precision of measurement of the order of 0·0004 in x or y as given by the standard deviation of a number of repeat measurements with the Beckman spectrophotometer, which thus has a differential sensitivity comparable with the closest commercial tolerances.

The same theme was developed further in a paper by Mr. P. S. Williams (Imperial Chemical Industries Paints Division), who compared results on the General Electric recording spectrophotometer and Librascope computer, the Donaldson six-filter colorimeter and the 'Colormaster' differential colorimeter developed by Glasser at the Dupont Company in the United States. When tested on various specimens, the two latter gave results in close agreement to each other, but differing slightly from the former on account of the special illuminating and viewing arrangements, to which reference has already been made. Changes in the spectral transmission of the filters with temperature were found to be one source of error in the Donaldson instrument, while the highest precision with the differential colorimeter (possibly as high as the smallest detectable difference by eye) is only achieved when comparison is made between samples of fairly similar spectral reflexion. This instrument uses a split beam to illuminate a standard and comparison surface, with two photo-cells (plus filters) to form a null balance bridge. Mr. J. W. Perry (Hilger and Watts, Ltd.) discussed the factors which must limit the accuracy of a colorimeter employing filter-screened photo-cells, with particular reference to the Hilger photoelectric tristimulus colorimeter. The fundamental difficulty is, of course, to obtain the correct sensitivity curves, but except for surface colours with irregular spectral reflexion curves, Perry considered that an accuracy of $\pm$ 0·005 could be achieved for a very large range of chromaticities with the Hilger colorimeter. Used as a differential instrument, the precision would be very much higher than this.

As the discussion on all four papers developed, one of the questions asked was, "Where do we go from here?" The chairman, Mr. R. G. Horner, promised that a future meeting would be held on colour tolerances, to provide an opportunity for the colour industries to define in more detail the limits to which they need to work and to consider the best form in which tolerances should be expressed. One particular point which requires clarification is whether the high discrimination which can be achieved in differential colorimetry needs to be matched by a corresponding precision and accuracy in absolute colour measurements. Evidently if the components of some product are manufactured at different parts of a works or at different times, the manufacturer must control the colour of each component to such an accuracy that they will appear to match when assembled together. Whereas the customer will be able to make a differential and highly critical judgment, the manufacturer may be denied this advantage during the actual production process. In principle, colorimetry is just the tool the manufacturer needs to assist him in this task. In practice, it looks as if the tool still requires some sharpening.

W. D. Wright

NEWS and VIEWS

Benjamin Franklin Medal of the Royal Society of Arts

The Council of the Royal Society of Arts has established a new award, to be known as the Benjamin Franklin Medal, which is to be made annually "to individuals who have attained early distinction, with promise of future achievement, in the promotion of arts, manufactures and commerce". The association of the Medal with the name of Benjamin Franklin is due to the fact that it was instituted in the year (1956) in which occurred not only the 250th anniversary of Franklin's birth, but also the 200th anniversary of his election to membership of the Society. The medal has been designed by Mr. Christopher Ironside. The first award of the medal is to Prof. F. C. Williams, professor of electrical engineering in the University of Manchester, "for his contributions to electrical engineering".

Prof. F. C. Williams, O.B.E., F.R.S.

Dr. F. C. Williams, as he then was, joined the staff at Bawdsey Research Station from the University of Manchester in March 1939 and was continuously employed throughout the War on the development of radar equipment. During this period, he was himself primarily responsible for the fundamental concepts on which many vital radar systems and devices and automatic servo-mechanisms were based. Dr. Williams resigned from Government service at the end of 1946 and since that time has held the chair of electrical engineering in the University of Manchester. During this post-war period his name has become associated with pioneering work on automatic electronic digital computers. In this field, among his more noteworthy contributions is an electrostatic information store, based on cathode-ray tube techniques, of extreme elegance and technical interest. Indeed, the first commercial high-speed electronic digital computer to become available in the United Kingdom was fundamentally based on Prof. Williams's cathode-ray tube information store. More recently, he has turned his attention to the design of rotating electrical machinery and is at present working on an original design for an induction motor, the speed of which is capable of being continuously varied over a wide range.

Geological Society of London: Awards for 1957

THE Council of the Geological Society of London has made the following awards for 1957: *Wollaston Medal* to Prof. Paul Fourmarier, the doyen of Belgian geologists, distinguished for his researches on rock structure, on the Belgian coalfields and on the economic geology of the Belgian Congo; *Murchison Medal* to Mr. H. G. Dines for his services to economic geology, particularly in reference to the metalliferous orefield of Cornwall and Devon; *Lyell Medal* to Dr. S. H. Straw, distinguished for his researches on the fauna and stratigraphy of the Silurian rocks and as a teacher of palæontology; *Bigsby Medal* to Prof. H. B. Whittington for his contributions to the knowledge of the trilobite fauna of the Lower Palæozoic rocks of Britain and North America; *Prestwich Medal* to Prof. J. K. Charlesworth in recognition of the value of his researches in the glaciation of the British Isles and on his memoir on the Quaternary Era recently completed; *Wollaston Fund* to Dr. J. R. Earp for his work on the Upper Silurian rocks of Wales and the Carboniferous rocks of north-west England; *Murchison Fund* to Mr. J. W. Pallister for his contributions to geological knowledge in the field of mineral and oil exploration and of government geological survey work in Uganda; moiety of the *Lyell Fund* to Prof. F. H. T. Rhodes for his authoritative work on the conodont faunas of the Carboniferous and Lower Palæozoic, and in recognition of his direction of research on a variety of topics both stratigraphical and palæontological, with special emphasis on palæoecology; another moiety of the *Lyell Fund* to Dr. T. Barnard in recognition of his work particularly in the field of Jurassic and Cretaceous micropalæontology.

Fuel Research in Great Britain: Dr. A. Parker, C.B.E.

DR. ALBERT PARKER retired from the post of director of fuel research in the Department of Scientific and Industrial Research on December 31. After postgraduate research at the University of Manchester on the combustion and detonation of gases and their specific heats at high temperatures, he was appointed lecturer in physical chemistry at the University of Birmingham. This was followed by large-scale investigations for the Institution of Gas Engineers and the University of Leeds on carbonization, water-gas manufacture and the disposal of gas liquor effluents. In 1928 Dr. Parker joined the Department of Scientific and Industrial Research as assistant director of water pollution research, and later became director. Important surveys were made of pollution in the River Tees and the Mersey estuary. In 1943 he was appointed director of fuel research and did much to improve efficiency in the use of fuel both in industry and in the home, and to abate atmospheric pollution. He was an acknowledged expert on the world's fuel resources, and his leadership and energy were invaluable in post-War reconstruction. Among Dr. Parker's many honours were the appointment as C.B.E. in 1946, the Osborne Reynolds Medal of the Institution of Chemical Engineers and the Telford Premium of the Institution of Civil Engineers. He was Thomas Hawksley lecturer of the Institution of Mechanical Engineers and Melchett lecturer of the Institute of Fuel and he received the Reginald Mitchell Memorial Gold Medal of the Stoke-on-Trent Association of Engineers. Dr. Parker has played an active part in many professional societies; he has been honorary secretary of the British National Committee of the World Power Conference, chairman of the Council of the Royal Society of Health and has been elected an honorary fellow of the American Public Health Association.

Dr. A. C. Monkhouse, at present deputy director of fuel research, has been appointed acting director following Dr. Parker's retirement.

Royal Society and Nuffield Foundation Awards

AWARDS under the Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme are announced as follows: Dr. S. Basu, reader in chemistry, University of Calcutta, to study the application of quantum mechanics to the solution of problems of chemical reactivity, at Oxford from February to July 1957; Dr. E. A. Boulter, member of the staff of the Microbiological Research Establishment, Porton, Wiltshire, to study the pox viruses and the virus of myxomatosis, at the Australian National University, Canberra, from March to July 1957; Dr. J. R. Clarke, university demonstrator (animal physiology) in the Department of Agriculture, Oxford, to study the cytology of the pituitary gland during the reproductive cycle in domesticated animals, at the Medical School, Dunedin, for a year from August 1957; Dr. D. W. J. Cruickshank, lecturer in mathematical chemistry, University of Leeds, to study theoretical aspects of the application of spectroscopic methods to the determination of molecular structures and, particularly, of very accurate molecular dimensions, at the National Research Council of Canada, Ottawa, for about three months from March 1957; Dr. H. J. Heinz, head of the Department of Parasitology of the South African Institute for Medical Research, Johannesburg, to enable him to travel overland to Nigeria in order to study ancylostomiasis in West Africa, commencing in December 1956 and staying about six weeks in Nigeria; Dr. V. R. Rao, reader in physics, Andhra University, India, to study spectroscopic techniques in cytology at King's College, London, for three months from April 1957; Mr. F. H. Sagar, senior lecturer in physics, University College, Auckland, to enable him to observe new acoustic techniques at the Imperial College of Science and Technology, London, and elsewhere in the United Kingdom, for about four months from December 1956; Dr. E. den Tex, senior lecturer in geology, University of Melbourne, to study research techniques and teaching methods in structural geology and petrology, with special reference to petrofabric analysis, at several centres in the United Kingdom, in March and April 1957; Prof. F. Walker, professor of mineralogy and geology, University of Cape Town (professor of geology, Queen's College, Dundee, from January 1, 1957), to study magnetism and differentiation of dolerite sills in Canberra and Tasmania, for about three months from June 1957; Dr. J. H. Warcup, senior lecturer in microbiology, the Waite Institute, Adelaide, to study the ecology of soil micro-organisms in agricultural systems, at Cambridge from October 1957 to July 1958; Dr. J. M. de Wet, senior lecturer in mathematics and applied mathematics, Potchefstroom University, to carry out research in statistics at the London School of Economics from December 1956 to July 1957; Mr. J. H. Willis, member of the staff of the National Herbarium of Victoria, Australia, to enable him, among other matters, to study herbarium technique and the trends of modern systematic botany at the Royal Botanic Gardens,

Kew, and the Natural History Museum, for a year from April 1957.

Rutherfordiana

With the permission of the Royal Society of London and the assistance of Dr. Ernest Marsden, the *New Zealand Science Review* has been enabled to reproduce in full in its August number (18, No. 8; 1956) the text of the Rutherford Memorial Lecture, entitled "The Discovery of Atomic Number", which Sir Charles Darwin delivered initially during the Nelson College centenary celebrations on April 5, 1956. Sir Charles gives a broad survey of the history of the outstanding contributions to the subject, including the leading part taken by Rutherford. He points out that with the discovery of the neutron and several more recent elementary particles, a fresh field of science has been opened up, demanding a wholly new kind of dynamics the principles of which have not yet been found, and he concludes by quoting words which Rutherford was fond of uttering in connexion with any subject he was working at: "I think this is a grand subject; there are so many things in it we don't know".

In addition to the Memorial Lecture, the August number contains a short article by Dr. Lyndon Bastings entitled "Rutherfordiana", in which he lists a number of extra items not noted in the bibliography of Rutherford's publications compiled by C. M. Focken and published in the *Transactions of the Royal Society of New Zealand* (68; 1938). Dr. Bastings has made a comprehensive collection of reprints of Rutherford's articles which has been accepted by the library of Canterbury University College for safe custody. Dr. Marsden in his introductory foreword mentions the existence of two more items of Rutherfordiana—a gramophone recording of a lecture given by Rutherford at Göttingen, and one of the earliest cinematographic records with sound film, made at the General Electric Company's laboratory in the United States in the early days of combined picture and sound track, of the actual spoken lecture delivered by Rutherford.

Institute of Personnel Management

Remarkable progress in the field of personnel management in industry is described in the annual report of the Institute of Personnel Management. Membership of the Institute is continuing to increase, and now consists of some four thousand members. Following the decision of the National Coal Board to develop its staff department, many personnel managers have been appointed throughout the coal industry. During 1955, the Institute's examination scheme was launched, and the first candidates have already been examined. A joint study undertaken with the British Institute of Management and the Institute of Cost and Works Accountants is being made into the cost of absence from work and labour turnover, as well as the most effective means of providing financial information to employees. In view of the considerable changes—economic, technological and social—which have marked the post-war period, a study group has been formed to examine the new conditions and other implications in personnel management thought and practice.

Living Conditions and Health

In 1951, a preparatory international conference of doctors discussed the possibility of an international exchange of facts and opinions on the effects of living conditions on health, with the result that the World Congress of Doctors for the Study of Present-Day Living Conditions was established and held an international conference in Vienna in May 1953. A report of this conference, by Dr. Alice Stewart (Oxford), appears in the first issue of *Health and Living Conditions* (Vienna 1, Wollzeile, 29/3: English edition available from Dr. A. Ryle, The Caversham Centre, London, N.W.5. Annual subscription, 26*s.*; single copies, 6*s.*). The journal is to be published quarterly, in English, Chinese, French, German, Russian and Spanish. It is edited by Dr. F. Scholl (Austria) assisted by an international committee, the British representatives on which are Dr. P. D'Arcy Hart, Prof. L. Penrose and Dr. Alice Stewart. The articles in the first number reveal considerable breadth of outlook. There are also reports on various symposia and conferences.

The Gower Peninsula

Mr. Duncan Sandys, Minister of Housing and Local Government, has confirmed an Order establishing the Gower Peninsula, Glamorgan, as an area of outstanding natural beauty. In this area, which is the first of its kind under the National Parks and Access to the Countryside Act, 1949, the local planning authorities have the special responsibility of preserving and enhancing the natural beauty of the landscape for the enjoyment of this and future generations. The designated area, which is partly in the county of Glamorgan and partly in Swansea county borough, is known far beyond the boundaries of Wales for its beautiful coastline, its rocky limestone cliffs, sandy bays and coves, and for its delightful wooded ravines stretching inland. It is particularly important from the recreational point of view, because it is so close to Swansea and other industrial areas of South Wales, for the population of which it has long been a natural playground with its attractive coastline and inland walks, and facilities for boating, bathing and fishing. The designation does not automatically provide any additional freedom of access to private land.

Marginal Grazing Land in Britain

The area of land used for hill and upland grazing in Great Britain is 14 million acres, or 31 per cent of all agricultural land in the country. The value of this marginal land is a much debated question, and in Report No. 3 in the series "Studies in Rural Land Use", B. R. Davidson and G. P. Wibberley have attempted to sort out the broad facts and put the discussion on a more rational basis ("The Agricultural Significance of the Hills". Pp. iv+63. The Secretary, Wye College, Ashford, Kent, 1956. 5*s.* net). The important contribution made by hill sheep and wool to the national home supply is abundantly clear. The breeding flock of about 4·5 million head provides a flow of some 2·5–3 million sheep to the lowlands and accounts for one-third to one-half of the sheep slaughtered annually in Britain. It also provides about one-third of the yearly value of the home-produced wool clip. In contrast, the contribution in cattle and beef is small, amounting to only 5–7 per cent of the United Kingdom production of cattle for slaughter. The quantity of milk produced, however, though only 3 per cent of the total national milk sales, is of considerable monetary value, particularly to the small upland farmer. As regards the

vexed questions of subsidies and economics, it appears that under the existing system hill farming is less efficient than its lowland counterpart, but there is no evidence that more is being paid to support agriculture in the uplands. Some confusion seems to exist regarding the purpose of the Government subsidy, whether the money is intended to be apportioned on a basis of efficiency, the amount and value of production or as a means of equalizing net farm incomes. From the present report, it appears that only under the first set of conditions is its object being achieved.

Cultivation and Purification of Shellfish

Two current publications from the Ministry of Agriculture, Fisheries and Food incorporate the results of recent researches on shellfish at the Ministry's laboratories at Burnham-on-Crouch and Conway. Dr. H. A. Cole's manual on "Oyster Cultivation in Britain" (pp. 45 + 23 plates. London: H.M. Stationery Office, 1956. 5*s*. net) is primarily intended for those contemplating oyster-farming, but could be read with advantage by all concerned with the industry. The first parts describe the areas suitable for oyster cultivation, pollution problems and the legal aspects. There is then a section on work throughout the season, including relaying, collection of spat, control of pests, and marketing, while other sections deal with making and reclaiming beds and the purchase of oysters for relaying. Many potential oyster-beds in Britain are being neglected; it is hoped that this booklet will provide a stimulus to the industry.

It is well known that mussels and other shellfish can be freed from sewage pollution by making use of the animals' own feeding methods to remove harmful bacteria. Until now, such treatment has involved large-scale processing and a permanent staff, and it is gratifying to learn that Mr. N. Reynolds has devised a simplified system of purification that can be operated by the fishermen themselves (Ministry of Agriculture, Fisheries and Food, *Fish. Invest.*, Ser. 2, 20, No. 8. London: H.M. Stationery Office, 1956; 5*s*. net). The washed mussels are given three 24-hr. baths in shallow tanks of sea-water filled on the incoming tide, hosed and packed in clean sacks. The bacteriological results have been comparable to those of the more expensive method.

Viruses in Wild Plants

THE information available on the general distribution and frequency pattern of viruses in weeds and wild species, some of which may become important in crop pathology, is still very scanty. In a study of virus in wild plants, W. D. MacClement and M. G. Richards (*Canadian J. Bot.*, **34**, 5, 793; 1956) have found that there are very few species which are free from possible virus infection. In comparison with this, most flowering plants growing under the surface of open water show a low but significant amount of virus. The indicated level of virus infection varies throughout each summer and from one summer to the next, but is often surprisingly high. The total annual infection under the conditions employed was approximately 10 per cent of the sample population. The amount of infection in all plants varies with species and location from 0 to 50 per cent. Total virus infection appears to be related to the growth-rates of plants. The types of virus included several common to commercial crop plants, many unidentified mixtures, and some distinctly new viruses.

Japanese Forestry Research

IN Report No. 3 of the Government Forest Experiment Station (Meguro, Tokyo, 1953) the forest soil survey of an area in the Amaji Mountain Range was dealt with (see *Nature*, 175, 672; 1955), and now Reports 6 and 7 continue those soil surveys, both with an extra brochure of beautifully executed soil maps (Tokyo, 1956). The unit dealt with in Report No. 6 is situated in the north-western part of the Gifu Prefecture in Central Honshu, and the investigations carried out are on the same lines of Report No. 3. In Report No. 7 each of the seven management units in the basin of the River Yoneshiro, Akita Prefecture, were surveyed, and the relationship between the soil properties and forest growth is discussed. The area is mostly hilly. Tertiary green tuff, sandstone, shale and conglomerate occupy 65 per cent of the area, and liparite, andesite and granite the rest. Annual mean temperature, precipitation, humidity and prevailing wind direction received attention. Recommendations are made on the regeneration of the forests either by artificial means, spruce being considered, or by natural regeneration where possible. The Japanese Forest Service has been very thorough in these valuable soil surveys, which are so essential when large areas are either to be afforested or rehabilitated after destructive utilization. The maps which accompany the reports are of high artistic value.

An Inexpensive Vacuum Pump

IN the *Museums Journal*, November 1956, Mr. E. Martin Burgess, of the Department of Egyptology, University College, London, describes a method for constructing a cheap and simple pump for evacuating impregnating chambers in remote places where there is no source of power. Recently, it was proposed that the Nimrud ivories should be impregnated with polyvinyl acetate in vacuum jars *at* Nimrud rather than bring them back to England for the operation, for however carefully such objects were packed, damage in transit would be almost certain to occur. Naturally, no water vacuum pump could be used at Nimrud. It was therefore necessary to devise a cheap, simple, light-weight pump which could be made easily. This was accomplished by adapting a car-tyre pump to operate in reverse, replacing the inner tube valve on the car wheel by a one-way valve open only on the suction stroke. Working details with diagrams are given in the paper quoted, and the apparatus would doubtless be useful in many instances where a water supply of sufficient pressure is not available.

Direction of Seismological Fault Movement in New Zealand

THE question of the direction of fault movement in New Zealand has been considered by G. A. Eiby from an examination of the direction of the initial movement on seismograms from Karapiro, Wellington, Cobb River and Kaimata (*Seism. Obs. Bull.*, No. *S*–101; 1955). The method used is largely that developed by B. Gutenberg in southern California (*Bull. Seism. Soc. Amer.*, 31 (4), 263; 1941). In this method earthquakes are considered as a group when the faults in the region have a reasonably uniform alignment. Most of the active faults in New Zealand strike north-east. Maps have therefore been drawn for each of the four seismological stations mentioned above, and each shows the epicentres of all well-recorded earthquakes between July 1, 1951,

and June 30, 1952, together with the direction of initial earthquake movement. A dotted line on each map is drawn perpendicular to the direction in which the seismograph is orientated, and two full lines are also drawn on each diagram perpendicular to each other through the station to show the boundaries between the regions of compression and dilatation as indicated by the initial movement on the seismogram. The general fault trend is parallel to one of these latter two lines. Geological evidence favours a north-east strike. According to this evidence, the western side of the faults must in general move north-eastwards relative to the eastern side. It is now proposed to examine a considerably larger series of records and to attempt to distinguish the finer details of the regional pattern.

Extragalactic Studies in the Southern Hemisphere

In an article on "Extragalactic Studies in the Southern Hemisphere" (*Occasional Notes Roy. Astro. Soc.*, No. 18; 1956), G. de Vaucouleurs refers at the beginning to the unbalance between our knowledge of the northern and of the southern sky, which is more serious in the field of extragalactic studies than in any other branch of astronomy. He then continues with a short history of extragalactic studies in the southern hemisphere, starting with Halley's expedition to St. Helena in 1679, though none of Halley's objects was actually extragalactic, and the credit for first observing these must be given to N. L. de La Caille during his expedition to the Cape in 1751–52. An account follows of J. Herschel's first systematic survey and of subsequent work by others, early photographic exploration, and reflector surveys of bright galaxies—with two tables, one giving details regarding the twelve brightest galaxies irrespective of hemisphere, and the other supplying similar details of twenty bright southern galaxies lying in declination between $-11°\ 21'$ and $-66°\ 40'$. As the Harvard "Survey of Bright Galaxies" is still the only source of magnitude for southern objects, there is urgent need for a photometric survey by modern photographic or photoelectric methods of the Shapley–Ames galaxies in the south to supplement the corresponding work by Stebbins and Whitford and others for northern objects. It is planned to obtain such observations at Mount Stromlo for the objects south of dec. $-35°$, already covered by the programme of direct photography with the Reynolds reflector. There is also need for further work on the luminosity distribution in the largest southern galaxies; and as the plates of the Reynolds survey are photometrically standardized, they provide ample material for such studies, especially for the larger galaxies. Under the heading of isophotometry, it is pointed out in the article that, while a beginning in this work was recently made in the northern hemisphere with the help of automatic recording isophotometers, there is none in service in the southern hemisphere. The latest model of Siedentopf's iris diaphragm photometer with 'magic eye' indicator has been found to be well adapted to the nearly continuous tracing of isophotes on photographs of nebulæ by manual operation; but it gives a satisfactory sensitivity only in the bright central regions of the nebulæ where the gradient of the photographic density is large and the effect of the granulation of the image is small compared with the variations due to nebular details. For this and other reasons, ordinary recordings or discrete readings are necessary.

Higher Technological Education

In an address on higher technological education given to the North of England Education Conference at Liverpool on January 3, Mr. A. A. Part, head of the Further Education Branch, Ministry of Education, said that State scholarship figures showed that, so far as men are concerned, science is now getting a reasonable proportion of the best brains and that the position in engineering is not discouraging, but there is much to be done before the schools could supply enough good students to enable the universities and technical colleges to meet their 1970 commitments in science and engineering. The technical college part-time course leading typically to the Ordinary and Higher National Certificates, which at present accounts for about half the annual output of 5,000 engineers, was likely even in 1970 to supply a significant proportion of technologists; but it is by the full-time or sandwich course at a technical college that the White Paper policy will stand or fall. At least 5,000 technologists should come by this route by 1970, in place of less than 1,000 at present. The designation of Chelsea Polytechnic and the Loughborough College of Technology brings the number of colleges of advanced technology to five, and since the White Paper was published a 75 per cent grant has been promised to the Faculty of Engineering, Bristol. As regards the building programme, £17 million worth is now under construction and programmes for the next three years totalling more than £40 million have been approved. The Preston Education Authority and the governors of the Harris Institute have agreed that the Development Group of the Ministry should design, in co-operation with them, the £500,000 extensions to the Institute which are due to be started early in 1958. The planning work is now in hand and the benefit of any researches or developments emerging from the project would be made generally available. Mr. Part believed that the technical colleges would provide more opportunities for educational pioneering than any other part of the educational system, but he stressed the need for closer co-operation with industry.

Report of the National Central Library

The fortieth annual report of the Executive Committee of the National Central Library, covering the year ended February 29, 1956, records a marked decrease both in applications and in issues of books and periodicals. Applications totalled 92,688, compared with 97,269 in 1954–55, and of these 70·67 per cent were dealt with successfully. Issues of separate volumes from or through the Library totalled 93,708, compared with 100,159 in 1954–55, and of these 16,890 were to university libraries, 15,723 to county libraries, 14,264 to adult classes, 10,382 to special outlier libraries, 5,275 to government departments, 4,476 to industrial and research organizations and 3,305 to overseas libraries. There are now 255 outlier libraries and the number of volumes lent by these libraries also fell from 21,256 in 1954–55 to 18,845. University libraries lent 26,466 books compared with 25,291 in the previous year and received 15,091 books from or through the agency of the Library, compared with 17,434 in 1954–55. The number of international loans continued to increase: 2,650 volumes were lent abroad by British libraries and 1,468 were borrowed on behalf of British libraries compared with 2,624 and 1,270, respectively, in the previous year, Western Germany remaining the

largest borrower (502), followed by Czechoslovakia (384) and Hungary (270). France (462), Western Germany (309) and Eastern Germany (158) were the largest lenders. The special committee formed by the Conference convened to inquire into book provisions for adult classes completed its investigations, and considerable progress has been made by the Implementation Committee considering methods of giving effect to the recommendations on library co-operation published in 1954. From January 1, 1958, the National Union Catalogue will cease to record British books included in the British National Bibliography, and it is hoped that the regional library systems will then be self-sufficient so far as the current material recorded in the Bibliography is concerned. Strong support was given to a recommendation for more liberal interlending of books from the reference departments of public libraries. Work continued on the Union Catalogue of Russian Books and Periodicals, and pressure on the British National Book Centre decreased.

Agricultural Scholarships

THE Ministry of Agriculture, Fisheries and Food is offering a number of scholarships for courses in an agricultural or allied subject, including veterinary science, at university departments of agriculture, agricultural colleges and farm institutes. The scholarships are open to the sons and daughters of agricultural workmen and to persons who are themselves *bona fide* workers in agriculture. Application forms, together with full details, may be obtained from the Secretary, Ministry of Agriculture, Fisheries and Food, Great Westminster House, Horseferry Road, London, S.W.1, or from education offices of county councils. The closing date for the receipt of completed applications is February 28. Selection is by interview, no written examination being held; but candidates must be able to satisfy the selection committee that they will benefit by a course of instruction and that they intend to follow an agricultural pursuit on completion of their training.

The Night Sky in February

FULL moon occurs on Feb. 14d. 16h. 38m. U.T.; new moon does not occur during the month. The following conjunctions with the Moon take place: Feb. 6d. 23h., Mars 0·8° S.; Feb. 17d. 03h., Jupiter 6° N.; Feb. 22d. 09h., Saturn 0·0° N. Mercury is visible low in the south-east just before sunrise at the beginning of the month, but conditions are not favourable for observation. Venus is too close to the Sun for observation. Mars sets at 0h. 20m., 0h. 15m. and 0h. 10m. on February 1, 15 and 28, respectively; its stellar magnitude decreases during the month from +0·9 to +1·2 and its distance from the Earth increases from 124 to 149 million miles. Mars is moving eastwards in Aries, being near δ Arietis at the end of the month. Jupiter rises at 21h. 20m., 20h. 20m. and 19h. 25m. at the beginning, middle and end of the month, respectively, and is visible during the remainder of the night; its stellar magnitude is −2·0, its distance in the middle of the month is about 428 million miles. Jupiter is in Virgo, moving westwards among the stars. Saturn rises at 3h. 50m., 3h. 00m. and 2h. 10m. on February 1, 15 and 28, respectively; its stellar magnitude is +0·7, and it is moving eastwards in Ophiuchus. Its distance from the Earth on February 15 is 955 million miles. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Feb. 4d. 20h. 49·6m., 51 Psc. (*D*); Feb. 10d. 19h. 51·5m., χ^1 Ori. (*D*); Feb. 11d. 0h. 34·4m., 64 Ori. (*D*). An occultation of Mars occurs on Feb. 6d. 23h. 51·6m. (*D*); reappearance will be difficult to observe at Greenwich owing to the low altitude of Mars. (*D*) refers to disappearance.

Announcements

DR. D. W. KENNARD, of the University of Cambridge, has been appointed Stothert Research Fellow by the Council of the Royal Society. Dr. Kennard will carry out research at the Physiological Laboratory, Cambridge, on the reflex activity of the spinal cord.

DR. J. T. EAYRS, of the University of Birmingham, has been appointed Head Research Fellow from October 1 by the Head Bequest Committee of the Royal Society. Dr. Eayrs will carry out research at the Department of Anatomy, University of Birmingham, on mechanism in neural integration.

PROF. H. G. WOOD, formerly professor of theology in the University of Birmingham, will deliver the Eddington Memorial Lecture for 1957 in the Arts School Lecture Theatre, Cambridge, on February 19. The title of the Lecture is "Thought, Life and Time".

RECENT developments in hydraulic controls and drives will be reviewed at a conference arranged by the British Iron and Steel Research Association, to be held during March 26–28 at Ashorne Hill, near Leamington Spa. The chairman will be Mr. W. M. Larke, of Stewarts and Lloyds, Ltd. Further details can be obtained from the Technical Secretary, Plant Engineering Division, British Iron and Steel Research Association Laboratories, 140 Battersea Park Road, S.W.11.

A CONFERENCE, open to all interested scientists, will be held at the time of the fifth annual meeting of the editorial board of the *Journal of Embryology and Experimental Morphology* during April 10–13. The conference will be held in the Department of Anatomy, University of Cambridge, and in the Strangeways Research Laboratory. Further information can be obtained from Dr. D. R. Newth, Department of Zoology, University College, Gower Street, London, W.C.1.

THE International Symposium on Macromolecular Chemistry, arranged under the auspices of the International Union of Pure and Applied Chemistry and the Czechoslovak Chemical Society, will be held in Prague during September 9–15. Prof. O. Wichterle is chairman of the organizing committee. The main topics proposed for the symposium are (*a*) physics and physical chemistry of macromolecular substances, and (*b*) polyreactions; further subdivisions will be considered. Provisional application forms can be obtained from the Symposium Organizing Committee, 5 Technická, Prague 6, and they must be returned before the end of February. Further information can be obtained from Dr. J. C. Bevington, Chemistry Department, The University, Birmingham 15.

IN *Nature* of January 12, p. 77, reference was made to the appointment of Mr. H. F. Tremlett as deputy director of the British Welding Research Association. His present post was wrongly given; he is head of the Welding Research Section of the Research and Development Department of the United Steel Companies, Ltd., at Rotherham.

THE COMMONWEALTH FUND

REPORT FOR 1955–56

THE thirty-eighth annual report of the Commonwealth Fund, for the year ending June 30, 1956, again stresses its appropriation to the universities to assist them in strengthening and improving their programmes of medical education. Of total appropriations of 15,140,154.82 dollars, 12,600,000 dollars was in unrestricted grants to nineteen universities for this purpose, and the report reviews in some detail the Fund's efforts to assist the medical schools of the United States during the past ten years. Of its total appropriations of about 40 million dollars, 51 per cent has been for medical education, mainly to some forty universities and medical schools, while medical research, experimental health services and advanced fellowships carried on in universities and by various types of organizations account for another 37 per cent of the total. The principle of giving unrestricted grants to universities for medical education emphasizes the Fund's conviction that medical education occupies a position of critical significance to the future of medicine, that its needs are urgent and the opportunities presented of exceptional promise, and this section of the report discusses with insight some of the basic problems presented by medical education and especially the fundamental questions whether medical education should continue to be a university function and the objectives of a university that require it to have a medical school.

Besides this new policy of granting unrestricted funds to universities for this purpose, grants totalling 559,723 dollars were made for nine specific projects or programmes in this field, of which six were new. The University of Vermont College of Medicine received a grant to enable the Department of Preventive Medicine to offer active leadership in the planning and organization of community health and medical facilities. A grant to the University of Virginia School of Medicine was to provide a programme for more effective care of ambulant patients and to assist students in the first year of study to learn something of the circumstances in which patients came to medicine for help. Baylor University College of Medicine received a grant for the purchase of television equipment to be used in teaching physiology and the State University of New York College of Medicine at Syracuse one for training pediatric educators which will facilitate a planned programme of post-resident experience.

In medical research, which received 717,546.60 dollars, the Fund has sought to concentrate its efforts in three areas likely to contribute new knowledge and increased understanding of man as a total organism. Of twenty-five programmes conducted during the year with Fund assistance in seventeen university medical schools, teaching hospitals or research laboratories, ten centred on the long-term relationships between chronic disease and social environment, the multiple social, emotional and physical factors which influence growth and the development of personality and pertinent neuropsychiatric problems; eight explored the complexities of the body's integrative mechanisms—the neurological and the endocrine systems and particularly their reaction under stress; and the remaining seven were concerned with basic physiological phenomena, particularly cellular phenomena. To the conventional method of project support the Fund has added the policy of fluid subsidies in modest amounts to enable individuals or departments of recognized distinction and competence to follow in any direction promising leads uncovered in their current research and develop them to a level where they can command project support on their own. One such award made during the year was to Prof. T. Puck, of the Department of Biophysics, University of Colorado School of Medicine, who has recently developed a unique plating method which makes possible the growing of whole colonies of cells from almost every cell.

Twenty-three fellowships were awarded during the year for advanced training, study and experience in medicine and closely allied fields, totalling 383,310 dollars, and the Fund this year inaugurated a new programme of special awards in support of creative work, designed for men of proved scholarly or scientific productivity in the health or medical sciences. The two awards during 1956 under this programme were to Dr. Florence Powdermaker, to complete, in collaboration with Dr. Z. De Fries, research for a monograph on a hitherto undescribed type of character disorder, and to Dr. Clayton Loosli, professor of preventive medicine, University of Chicago, to analyse original data collected on the structure of mammalian lung tissue and on the origin and development of bacterial blood infection.

Block grants were made to educational and professional institutions for the education of nurses at the master and doctorate levels, and in the programme of international fellowships, for which 712,915 dollars were allotted, 46 Commonwealth Fellows were selected to spend a year of study and travel in the United States in 1956–57. These included four Home, five Dominion and two Oversea Civil Service Fellowships, and in addition second-year extensions to complete their studies were granted to fourteen of the forty-five Fellows currently in residence.

THE BRITISH COUNCIL

REPORT FOR 1955–56

THE annual report of the British Council for 1955–56 (pp. vi+94+6 plates. London, 1956) takes the form of a general survey of the year's work, with some impressions of the Council at work by its chairman, Sir David Kelly, and an article on the teaching of English overseas, together with the usual appendixes such as lists of officers and committees, analysis of expenditure, statistics of university interchange, overseas visitors, courses and lecture tours, etc. More than half the literate population of the world speak English as a first or second language or use English as an indispensable instrument for vocational purposes, or are studying the language. In recent years about half the world's output of scientific literature has been published in English. Nevertheless, English will not become established as a world language without serious and systematic encouragement, and the special article describes the steps which the British Council is taking,

within its limited means, to meet the demand for qualified teachers and suitable teaching material. This includes direct teaching in twenty-five centres and institutes throughout the world, but mainly in southern Europe and the Middle East, with an aggregate of nearly 20,000 pupils; co-operation with educational authorities overseas, in training and advising teachers and in the preparation of syllabuses and text-books as well as seconding of officers for teaching duties; assistance to non-official institutions engaged in organized teaching of English; assistance in broadcasting English lessons; provision of facilities for overseas teachers to study in the United Kingdom; and the publication of periodicals devoted to the problems of the teacher of English. Of the eighteen full-time university posts subsidized by the Council at March 31, 1956, in Burma, Germany, Greece, Indonesia, Japan, Lebanon, Thailand and Turkey, all except one (the visiting professor of English literature at the American University of Beirut) were in English.

Travel grants for study visits to the United Kingdom were made during the year to three university teachers or postgraduate research workers from Canada, nineteen from Australia, four from New Zealand, eight from South Africa, eleven from India, and three from Pakistan, while three grants were made for similar visits from the United Kingdom to Canada, two to Australia, three to South Africa and one each to New Zealand, Malaya and the West Indies. Visits from British universities to universities in 13 European countries during the academic year 1954–55 totalled 52, and United Kingdom universities received 55 visits from universities in these countries. Of the 4,472 overseas visitors to the United Kingdom during the year under the auspices of the British Council, 1,194 were concerned with education, 1,005 with social science, 874 with science and 817 with medicine, while 5,038 students were met on arrival, of whom 4,655 were from British Colonial territories and 120 from Commonwealth countries. Of these, 373 were provided with permanent accommodation in British Council hostels, 1,242 with transit accommodation in such hostels on arrival and 1,611 with temporary hostel accommodation while on study or recreation visits. Of the lecture tours and advisory visits overseas arranged by the Council, 33 per cent were in science, medicine, agriculture and engineering, and 26 per cent in education, sociology, philosophy and law.

Related to the teaching of English overseas is the support given by the Council overseas to British schools and schools run on British lines, and there is a keen demand for places in schools of this kind in many parts of the world. The Council is co-operating with the Iraq Government in establishing a new secondary school in Iraq on a site to be provided by the Iraq Government and is co-operating with the Libyan Government in establishing a new school in Libya. An extensive tour of schools in India run on the lines of British public schools was arranged early in 1956, and the Council is also in close touch with similar schools in Pakistan. In student welfare a main difficulty has been in securing suitable premises to replace the present inadequate Overseas Student Centre in Hanover Street. A notable event was the conference at Cambridge in July 1955, attended by 98 university rectors and other delegates from all the Western European Union countries, together with 16 rectors and representatives of other Council of Europe countries which discussed specialization and general culture; the autonomy and independence of universities; the selection, training and welfare of students; and the university and the community. In science the Council gives the highest priority to fostering closer contacts between overseas specialists and their opposite numbers in Britain. During the year, 55 per cent of the Council Scholars, 34 per cent of the United Nations Fellows, and more than half the visits organized under the Foreign and Commonwealth University Interchange Scholars were concerned with scientific subjects. An advanced course on radioactive isotopes in the University of Concepcion, Chile, was organized jointly by the Council and the Board of Trade.

Much of the Council's overseas expenditure is financed from its own earnings in local currency, and over the past two financial years only about one-third of its net Government grants was spent overseas. Of this £950,000, between one-third and one-half was spent in the sterling area. Against this has to be set certain invisible exports such as direct earnings in foreign currency from United Nations Fellows, Colombo Plan trainees, donations for special purposes and indirect earnings in foreign currency, such as the £300,000 or more spent privately in the United Kingdom by students, Council visitors, etc.

Sir David Kelly's impressions add to the popular appeal of the report and should help to remove some long-standing prejudices and misunderstandings. Sir David points to a restoration of confidence and the resumption of permanent recruitment which has been suspended since 1949, but he stresses the inadequacy of the Council's resources for coping with the opportunities offered to it, especially in European countries.

ELECTROCHEMISTRY AND ELECTROLYTIC SOLUTIONS

THE Physical and Inorganic Group of the Victorian Branch of the Royal Australian Chemical Institute held a three-day discussion meeting on "Electrochemistry and Electrolytic Solutions" during August 6–8, 1956, in the Chemistry Department of the University of Melbourne. The discussion was attended by one hundred and fifteen persons.

The meeting was opened by Prof. R. H. Stokes (University of New England, Armidale) with a paper on "Electrolyte Solutions". The remainder of the day was devoted to research contributions. The first, by Prof. R. A. Robinson (University of Malaya) and Prof. R. H. Stokes (University of New England, Armidale), dealt with "The Role of Viscosity in Conductance and Diffusion of Concentrated Electrolytes". While it is clear that the viscosity is predominant in determining conductance and diffusion, and the current theoretical expressions of Onsager and Falkenhagen require an additional term which must approximate to the first power of the viscosity, it is not clear what the exact viscosity function is. On the experimental side, a description was given of Prof. Stokes's apparatus for measuring transport numbers, in which the solutions are analysed conductometrically both before and after the run. The ratio of the conductance of any salt in water to that of the same salt in a solvent of different viscosity (for example, 10 per cent sucrose, 10 per cent glucose, 10 per cent mannose in water) is almost independent of the electrolyte, but it is not equal to the inverse

ratio of the corresponding viscosities. This confirms that the first power of the viscosity is not that which determines the experimental properties. The next paper, by Mr. L. A. Woolf (University of New England, Armidale), on "Tracer Diffusion of Iodide Ion in Concentrated Chloride Solutions", dealt with the diffusion-rate of 10 per cent iodide ion in potassium chloride. This was measured in a porous glass diaphragm cell, the iodide ions being titrated potentiometrically with silver–silver iodide electrodes. Good agreement was found with the results obtained by the capillary cell method, discussed by Dr. R. Mills (Australian National University, Canberra), in his paper "Diffusion Studies in Dilute Solutions". Dr. Mills considered the relative merits of the three different methods of measuring diffusion rates with radioactive tracers: (*a*) open-ended capillaries, (*b*) diaphragm cells, (*c*) capillary cells. Of these, open-ended capillaries seem to be best but lead to steadily falling diffusion coefficients. The study of the diffusion rate of sodium ion in sodium chloride gives a curve different in shape from that of Wang but still showing a shallow maximum with concentration. The difficulties of testing the theoretical expression for limiting diffusion coefficient of single ions at low concentration were discussed. A new apparatus was described for studying diffusion-rates at these low concentrations with continuous monitoring of the activity left in the capillary.

Prof. Robinson delivered a paper on "Mixed Electrolytes", in which he applied Glueckauf's volume statistics to derive an equation of the Harned type for mixed electrolytes. It emerges that α_{12} and α_{21} can be expressed as functions of parameters which depend only on those for pure electrolytes. This enables the properties of a mixed solution to be calculated approximately from the known properties of the constituents. A paper by Dr. H. A. C. McKay (Atomic Energy Research Establishment, Harwell) on "The Activity Coefficients of Nitric Acid, a Partially Ionized 1 : 1 Electrolyte" was read by Prof. Stokes. Dr. McKay pointed out that the activity coefficients of nitric acid in water appear to be anomalous when compared with those of strong electrolytes. Nitric acid solutions were treated temporarily as ternary systems containing water, ionized, and un-ionized nitric acid, and cross-differentiation relations were used for relating the experimental activity coefficients to the activity coefficients of the hypothetical, fully ionized nitric acid. The latter were then calculated with the help of spectrophotometric data, and were shown to lie on a curve similar to those of strong electrolytes.

Dr. M. Spiro (University of Melbourne) discussed "Transference Numbers of Weak Electrolytes". For iodic acid, the dissociation constant of which is 0·167 at 25° C., the problems of measurement include the choice of a suitable non-gassing electrode and of appropriate indicator electrolytes. Boundaries for the HIO_3/KIO_3 system behave normally, but the velocities of HIO_3/H_3PO_4 boundaries, although independent of the H_3PO_4 concentration, increase with increasing current. This current variation was studied in detail. Iodic acid obeys the Debye–Hückel–Onsager theory as well as do strong electrolytes when the ionic strengths are used in place of the concentrations. "The Theory and Properties of Polyelectrolytes" were discussed by Prof. D. O. Jordan (University of Adelaide), with particular attention to electrostatic potential, colligative properties, and properties dependent on the shape of the polyion. The dissociation constant of a polymeric acid changes with the degree of ionization. The relation between pK and pH is complicated and involves the free energy change occurring when the charge on a polyacid is changed. This is equivalent to evaluating the surface potential of the polyacid.

The second section dealt with "Electrode Processes", and was opened by a review paper from Dr. B. Breyer (University of Sydney). The fine structure of the double layer, particularly that pictured by Grahame for a mercury surface, was discussed. The first research contribution in this session was on the "Criteria of Electro-reversibility", by Dr. S. Hacobian (University of Sydney), who dealt with general aspects of reversibility from the thermodynamic and kinetic points of view. Particular distinction was drawn between the reversibility of electrochemical reactions and the reversibility of the electrode process. The term 'reversibility' of electrode process is losing its original thermodynamic significance since it frequently refers to a particular set of experimental conditions. Mr. D. J. Casimer next delivered a paper on "Hydrogen Discharge Catalysis by Organic Heterocycles", with Dr. L. E. Lyons and Mr. A. J. Harle (University of Sydney) as co-authors. By studying the effects of quinoline derivatives, the mechanism of hydrogen discharge can be investigated. The catalytic effect of reduced quinolinium ion depends on the concentration and the pH, but is independent of the area of the dropping electrode, and disappears at large negative potentials. The results may be explained in terms of adsorption of the catalyst on the mercury surface. At negative potentials the catalyst is desorbed and the wave disappears. The adsorbed catalyst is protonated by reaction with the buffer, with production of hydrogen. Dr. S. Hacobian read the paper by Dr. H. H. Bauer (University of Sydney) on "Electrode Processes in Organic Polarography". Organic substances are adsorbed at the electrode even when the d.c. polarograms provide no indication of such adsorption. Thus a.c. polarography or a similar technique is imperative if the full mechanism of the reduction of an organic compound is to be elucidated.

"Electrode Potential Studies in Passivity" was the subject of the contribution by Mr. W. T. Denholm (University of Adelaide). He first described the electrochemical techniques employed in the study of the properties and mode of growth of passive films. The results of an investigation of the passive behaviour of iron in a variety of buffer solutions free from inhibiting anions were presented. The passive behaviour of iron approaches that of the noble metals most closely when the pH is about 11·5. It is then covered with approximately a monolayer of adsorbed oxygen. The film grows by discharge of hydroxyl ions on to surface atoms which retain their metallic lattice sites. Growth does not begin until the potential reaches the level at which ferrous ions may dissolve. Mr. K. F. Lorking (Aeronautical Research Laboratories, Melbourne) followed with a contribution on "An Experimental Investigation of the Double Layer at Working Electrodes". An electrode of large surface area (in comparison with the volume of the electrolyte) is used for producing a significant change in concentration of ions participating in the double layer process. Gold powder is used as an electrode as it is a soft metal having a thin oxide film. Salts with anions which are not strongly adsorbed at mercury surfaces are chosen as electro-

lytes. Solutions of nitrate, perchlorate and sulphate show *p*H changes as the anode potential is increased, with variations in the rate of change of *p*H with potential over the potential range corresponding to oxide formation. These results demonstrate the influence of anode potential on the distribution of hydrogen and hydroxyl ions in the electrical double layer. Dr. J. H. Bradbury (Commonwealth Scientific and Industrial Research Organization, Wool Textile Research Laboratories, Geelong) discussed the "Theory of Dead-stop Titration". Particular attention was directed to the titration of Fe^{2+} with Ce^{4+}. The current can be shown by thermodynamic argument to be dependent on the Fe^{2+} concentration, and hence on i/k_1, the ratio of the current between the electrodes to the diffusion constant in Fick's equation. From graphs of i/k_1 against volume of titrant the importance of various variables can be assessed. Greater accuracy is obtained by working at low voltages (about 0·010 V.). In addition, accurate titrations between 10^{-4} *N* reagents should be possible provided they form reversible redox systems, the standard electrode potentials of which differ by more than 0·20 V. The final paper in this session, entitled "Direct Current Polarography of the Ferrous–Ferric Systems in the presence of Alternating Voltages", was given by Mr. G. S. Buchanan (New South Wales University of Technology). If an a.c. voltage is superimposed on the normal d.c. potential, rectification of the a.c. current will occur, depending on whether or not the electrode process is reversible. Application of this principle to polarography of the ferrous–ferric oxalate system was reported in some detail, together with the results obtained by adding surface-active substances such as cyclohexanol.

The first paper in the third session, concerned with applications of electrochemistry, was delivered by Prof. D. O. Jordan and was entitled "Charge Determination in Poly-electrolytes". While there are a number of possible methods for determining the charge on the polyion, only the electrophoretic mobility or electrical transport provides information which is easily interpreted. The former suffers from the disadvantage that the size of the ion is not usually sufficiently accurately known. The ionic charge can be determined by the method of Huizenga, Grieger and Wall (*J. Amer. Chem. Soc.*, **72**, 2636; 1950), using sodium-22 as a tracer to measure the change in concentration of sodium in the electrode compartment of a Hittorf transference cell. The charge on the polyion decreases with decreasing polyion concentration down to low concentrations and then increases. Mr. E. F. Woods (Commonwealth Scientific and Industrial Research Organization, Wool Textile Research Laboratories, Geelong) followed with a paper entitled "The Application of Moving Boundary Electrophoresis to the Interaction of Proteins with Ions". Some examples were given of the application of the method to the study of antigen–antibody and protein–detergent reactions. Difficulties in interpreting electrophoretic effects were illustrated with reference to electrophoresis of proteins in acids containing amino-acid buffers. Dr. J. A. Friend (University of Tasmania) next presented a paper in collaboration with Mr. N. K. Roberts on "A Polarographic Study of some Würster Salts". At the dropping mercury electrode, and at a platinum micro-electrode, aromatic para-diamines give well-defined anodic waves in solution. Solutions of the Würster salts derived from these give either single waves (entirely cathodic) or double waves with both cathodic and anodic components. One electron is involved in each step. In "Amperometric Titrations of Molybdenum and Arsenic", Mr. G. H. Aylward (New South Wales University of Technology) showed that molybdates may be determined in concentrations of about 0·3 mgm. Mo/50 ml. (accuracy ± 0·001 mgm.) by titrating with lead nitrate in a supporting electrolyte of sodium acetate–potassium chloride of *p*H 3·5. At the potential selected, − 0·8 V. versus standard calomel electrode, both lead and molybdate ions are reduced. Arsenates are not reduced in this solution, though they are reduced at *p*H 6·0 if the acetate is free from chloride.

The last afternoon was devoted entirely to industrial applications. The first paper was on "Fused Electrolysis", by Prof. E. C. R. Spooner (University of Adelaide). Lead is extracted from galena at Port Pirie by direct electrolysis in molten lead chloride at 500° C. using bipolar electrodes (Halkyn process). The current efficiency increases, and the applied voltage decreases with increasing concentration of lead sulphide, because of the depolarizing reaction of $Pb + PbS \rightarrow Pb_2S$. This process for obtaining lead is potentially quite feasible, but much more work is needed before it can be regarded as established. Mr. A. S. Gill (Electrolytic Zinc Co., Ltd., Hobart) followed with "Some Aspects of Hydrogen Cell Operation". In the commercial production of electrolytic hydrogen, resistance losses and over-voltages can easily account for 50 per cent of the applied voltage. The use of a high operating temperature (75° C.), a potassium hydroxide electrolyte and iron cathodes with low hydrogen over-voltage helps to reduce these losses, while nickel-plated anodes are satisfactory for resisting oxidation and solution. Since impurities are cumulative, the feed water must be of high purity. Zinc, lead and chloride impurities and deposition of iron with puncturing of diaphragms are the chief troubles encountered. Dr. A. Walkley (Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization, Melbourne) delivered a paper in collaboration with Mr. D. F. A. Koch and Mr. H. R. Skewes entitled "Some Problems in the Electro-winning of Copper". Recent methods of roasting copper–iron sulphide ores result in calcines containing oxides and sulphates of copper and iron so that, when leachates prepared from them are electrolysed, sulphuric acid builds up in the circuit. Solutions containing H^+, Fe^{3+} and Cu^{2+} have thus to be stripped of copper before being discarded. The deposition of excessive copper from such solutions at an economic current efficiency presents many problems. The significance of turbulent and non-turbulent flow in the electrolyte was discussed. Small amounts of molybdenum have been found to be co-deposited with the copper, causing changes in its physical properties.

A contribution from Dr. C. S. Hocking (I.C.I.A.N.Z. Research Laboratories, Melbourne) followed. The theory of ion-exchange membranes was applied to a number of industrial problems, including water purification, caustic soda production, and acid recovery from spent liquors. Dr. M. Spiro read the last paper, on "The Effect of Current Density on the Transport of Ions through Ion Selective Membranes", by Dr. T. R. E. Kressman and Mr. F. L. Tye (Permutit Company, Ltd., Sydney and London). A method was described for measuring directly transport numbers in multicompartment electrodialysis cells at current densities and concentration differences

similar to those used in practice. At high current densities, the ions are transported through 'Permaplex' *C*-10 and *A*-10 membranes faster than they can get to the membrane interface. At low current densities the transport numbers decrease with decreasing current density because concentration diffusion partially counteracts the electrical migration. When this effect is allowed for, the true transport number of the sodium ion in 'Permaplex' *C*-10 in 0·1 *N* solution is found to be 0·98, and its diffusion coefficient $8{\cdot}1 \times 10^{-5}$ cm.²/sec.

J. F. Duncan

RAINFALL STATISTICS IN THE BELGIAN CONGO

In standard books of climatology published even since 1945 laments are to be found about the scanty nature of the data on the rainfall of equatorial forest areas. This reproach is now being rapidly removed and nowhere more rapidly than in the Belgian Congo, where the National Agronomic Institute has published during the past few years several detailed papers by F. Bultot. In a recent publication*, M. Bultot presents the first analysis, using modern statistical methods, of the rainfall regime in an equatorial continental tropical region without a monsoon wind regime. Rainfall in the Congo falls in scattered thundery downpours. The data used cover twenty-nine years for Eala in the north-west and for varying periods of more than twenty years for fourteen other stations in the area.

The problems investigated are the frequency of falls of different intensity, the probability for two or more days of rain exceeding 15 mm. to occur in succession, and the variation in the intensity of rainfall during a shower. It is found that rain of more than 0·1 mm. falls on one day in four and that the number of days in a year of 15 mm. or more of rain is less than ten or more than sixty on less than one year in twenty, and the number of days of 50 mm. and 80 mm. can only exceptionally exceed twelve and four, respectively. There is a marked annual variation, corresponding to the movement with the Sun of the tropical rainbelt, of days with 15 mm. or more of rain and a much less marked one, except in the central Congo where it vanishes, of days of 50 mm. or more.

A very interesting fact is that there is no persistence of heavy rainfalls. The probability, in fact, that 15 mm. or more will fall on the day following one with such amount is practically equal to the overall probability of a daily fall of that amount. In temperate regions there is appreciable persistence for rain days as a whole, though the degree of persistence for amounts of 15 mm. or more does not appear to have been investigated. The daily maximum expected to be exceeded only once in ten years is about 120 mm. and once in fifty years is 150 mm. It is pointed out that in Ireland the corresponding values are 64 mm. and 81 mm.

Study of a number of individual falls shows that the rate of rainfall is heaviest within a quarter of an hour from the beginning and rarely exceeds 2 mm. per minute. Only about 25 per cent of all falls continue for more than four hours. The common opinion that tropical showers almost always occur in the afternoon is incorrect. It is found, however, that at most places there are relatively few showers during the morning. The afternoon showers are shorter and more intense than those at night. Finally, in a restricted study of area rainfall it is found that over areas up to 175 sq. km. the frequencies of a given amount diminish exponentially with the area.

There is no discussion of the synoptic meteorology of rain. Perhaps in a future publication M. Bultot will investigate such matters as the incidence of showers or absence of showers over wide areas and the corresponding stream-lines of wind flow.

G. A. Bull

* Publications de l'Institut National pour l'Étude Agronomique du Congo Belge : Étude Statistique des Pluies Intenses en un Point et sur une Aire au Congo Belge et au Ruanda-Urundi. (Bureau Climatologique Communication No. 11.) Par F. Bultot. Pp. 90. (Brussels : Institut National pour l'Étude Agronomique du Congo Belge, 1956.) n.p.

LVOV GEOLOGICAL SOCIETY

The Lvov Geological Society celebrated in 1956 the tenth anniversary of its foundation. Lvov Geological Society is attached to Ivan Franco's State University of Lvov, founded in 1661. There the teaching of geology began at the end of the eighteenth century, when the chair of geognosy and oryktognosy was founded, no doubt under the impulse of the prevalent Wernerianism. In 1852 a mineralogical museum and in 1864 a chair of mineralogy were established. The first professor of mineralogy was Ferdinand Zirkel (1838–1912), the distinguished pioneer of microscopical petrography. It was during his residence in Lvov (1864–68) that Zirkel published his "Lehrbuch der Petrographie" (1866).

The Lvov Geological Society is now a very vigorous institution, comprising more than a hundred and twenty members. It is subdivided into a mineralogical section, presided over by Prof. E. K. Lazarenko, and a regional geology section by Prof. O. S. Vyalov. There is also a branch at the Chernovtzy State University. The principal object of the Society is the promotion of the study of geology, petrology, mineralogy and mineral deposits of the Western Ukraine, as well as other parts of the Soviet Union. It is interesting to note, however, that many contributors to its periodical publication reside in places distant from Lvov and even outside the Soviet Union, for example, in Bulgaria, China and Bolivia. The Society, besides its normal activities, has two special functions, namely, the organization of special surveys or studies in either pure or applied geology, and also of conferences. The Society has already undertaken the following surveys: a geophysical survey of Lvov region; a geological and geomorphological survey of certain Carpathian regions; a petrographical and mineralogical study of igneous and sedimentary rocks; and finally, a specially organized survey of the Eastern Transbaikal region in Siberia. The conferences organized by the Society comprise the subjects of tectonics, stratigraphy, petrology, economic geology and history of geology.

The publications of the Society are: (1) *Mineralogichesky Sbornik* (*Mineralogical Magazine*), each annual volume of some 400 pages containing about forty original papers; (2) *Trudy* (*Transactions*) *of Lvov Geological Society*, comprising geological, petroleum geology and petrographical series; (3) *Geologichesky Sbornik* (*Geological Magazine*), replacing *Trudy* since 1955; (4) monographs on the petrology of the Ukrainian crystalline massif, granite plutons of Kazakhstan, migration of oil, tourmaline, bentonite clays, the Eastern Transbaikal region and Aldan

region in Siberia. The high standard and the quality of print and illustrations of these publications are in no small measure due to the editorial board presided over by Prof. E. K. Lazarenko.

Besides these publications of the Society, there is also *Uchonye Zapisky* (*Scientific Annals*) of the University of Lvov, the Geological Series of which is edited by Prof. O. S. Vyalov.

The library of the Society contains more than 10,000 volumes and is constantly growing, partly due to a large number of exchanges with other societies, both at home and abroad. S. I. TOMKEIEFF

SOCIOLOGY IN THE UNITED STATES

FOLLOWING publication of its "International Register of Current Team Research in the Social Sciences", Unesco's series "Documentation in the Social Sciences" is now being extended by the addition of three reports covering recent trends in economic, political science and sociological research *in the United States* (*Unesco: 19 Avenue Kléber, Paris, 16e.*). In view of the enormous amount of social science research that is being pursued there, it has been thought most appropriate to give a bird's eye view of general tendencies and pre-occupations rather than seek to catalogue in detail all that is being done over a given time by every serious researcher. These reports have been commissioned from eminent specialists who are in close touch with developments and whose accounts constitute an authoritative guide to progress within these three major disciplines.

The work on sociology has been edited by Hans L. Zetterberg, of Columbia University, who traces its considerable growth in the past decade. In 1945, the American Sociological Society had 1,242 regular members; in 1954, 4,350 members—a gain of 250 per cent. Among about two thousand institutions offering instruction on a higher than secondary level, about 98 per cent have prospectuses listing courses under the heading 'sociology'. On the average, the four-year college offers about a dozen different sociology courses. It would appear that at least a third of the college population in the United States, during one time or another in their college career, follows a sociology course and that about one out of ten Americans at the age of twenty has followed at least one class in sociology. The bulk of students enrolling in sociology courses do so during their first or second year of college, that is, at an age between seventeen and nineteen. The majority of those teaching sociology to undergraduates in American colleges are indeed best compared with teachers in upper-sixth forms in grammar schools.

Slightly less than 2 per cent of college students choose sociology as their major field of concentration. Since there is no established occupation or profession of 'sociologist', these students select sociology with other vocational interests in mind.

About one-fifth select teaching and one-quarter various forms of social work, while one-tenth take up personnel work in industry. Many of the courses deal with marriage and family life, social problems and criminology. The social problems courses are not designed to help students 'solve' social problems but rather to open their eyes to their existence and to prepare them for participation in democratic discussion of these problems.

Some sixty universities offer graduate instruction in sociology and grant higher degrees. In 1953, for example, 141 Ph.D.s in sociology were awarded by these institutions.

The organization of an American graduate department in sociology shows several interesting contrasts with its European counterpart. For example, a typical European sociology department has one professor who is the administrative head and who also sets the tone for the scholarly orientation of the department. An American graduate department, on the other hand, contains several professors who do not usually represent the same school of thought; in fact, university administrators often make efforts to obtain representation from different specializations and occasionally even contradictory emphases. This gives the student a chance to learn different aspects of sociology without having to go to different universities. The graduate departments of sociology are also centres of sociological research, and most sociological projects undertaken in the United States are headed by a university professor. Most of these projects involve a staff of several people in addition to the person in charge. The excellence of American training in sociology is in no small part due to the widespread possibility for students to participate as research assistants in projects where they can learn this uncodified research tradition.

Several leading universities have found it convenient to organize separate agencies to handle larger aspects of social science research. Some of these agencies are adjuncts to the sociology departments, such as the Bureau of Applied Social Research at Columbia University and the National Opinion Research Centre at the University of Chicago; others are more independent agencies like, for example, the Research Centre for Group Dynamics at the University of Michigan. Several of these agencies are interdisciplinary in character and practice and may include psychologists, anthropologists, political scientists and economists.

The fact that more than one person is involved in the typical sociological research project means that the long tradition of research by the lone scholar has been broken. This type of organization makes it possible to complete large-scale projects in a short time, whereas the solitary research worker might have to spend a long time completing the routine office work which constitutes 90 per cent of modern sociological research. This organized research increases the power of the worker involved; he can undertake larger projects and complete them in a shorter time. It also increases the efficiency of the research worker, since few sociologists can claim excellence in all the varied tasks that enter into a project.

On the other hand, organized research has come into conflict with the traditional procedures of awarding academic and scholarly recognition, which are still based on evaluation of contributions submitted by one scholar.

It is plain that sociological research in the United States, precisely because it is organized research, is expensive research; the average sociological project probably costs more than the average project in history, political science or economics. During the past decade the proportion of government support has decreased somewhat, while the proportion of foundation support has increased. The most important agencies have employed prominent sociologists on their staff, and it is the practice among

nearly all of them to consult with university sociologists before acting on a proposal. This means that academic representatives maintain the main part of the control over available funds.

In Europe it is, on the whole, more difficult to get subsidies for research than subsidies for the publication of research. In spite of the great amount of support for research in the United States, there is both proportionately and absolutely little subsidy to publish scholarly reports. This means that the number of monographic reports published in the United States is lower than one would expect in view of the total volume of research. Elementary textbooks appear to be about the only risks that most commercial publishers are willing to take. To simplify the students' task of locating important articles, a number of so-called 'readers' have appeared during the past decade which reprint in book form a series of articles related to a given topic.

In a survey of recent research projects in American sociology, Zetterberg shows that the common charge that sociology merely elaborates the obvious is often without justification. For example, it has been generally held that insanity-rates have increased as society becomes more urbanized and industrialized. Goldhamer and Marshall have shown that over the past century in the State of Massachusetts there has been no such increase. Numerous commentators have expressed the view that the rate of social mobility has declined over the past decades in the United States. The study of intergenerational occupational mobility by Rogoff and the study of access to the business *élite* by Keller show no general decline, although the avenues to success might be different from in the past. It has long been an axiom that the rate of social mobility is higher in the United States than in Western Europe: examination of the available evidence by Lipset and Rogoff fails to sustain this belief. Democratic ideologists have glorified the voter who first listens to all the arguments and then makes up his independent mind to deliver his vote. The election studies by Lazarsfeld *et al.* and Berelson *et al.* show that group pressures in most cases determine the way the vote is cast and that the voter who does not make up his mind until the campaign is over is likely to be the least informed and the most confused.

The rest of the book gives detailed surveys of work which has been carried out in the past decade or so under the headings of method and theory, social institutions and groups, rural and urban sociology, sociology of social stratification, criminology, sociology of ethnic relations and the sociology of mental health.

TRIGONIA: A LIVING FOSSIL

At the close of the Mesozoic era the bivalve *Trigonia* gradually became less abundant in European seas and, to all appearances, soon became extinct. Their shells do not occur as fossils in the rocks formed during Tertiary time, and geologists were convinced that they had died out. Donald F. McMichael has described how the French naturalist, Peron, who, with his fellow collectors on the voyage of the French exploration ship *Geographe*, found on a beach in southern Tasmania a shell which seemed to be the same as well-known fossils. Back in France, the great zoologist, Lamarck, described the shell as the first living *Trigonia*, calling it *T. margaritacea* because of its beautiful iridescent interior (*Aust. Mus. Mag.*, **12**, No. 3; 1956).

Two other French naturalists, Quoy and Gaimard, who sailed with the *Astrolabe*, carried out searches for a living specimen. In King George's Sound and in Westernport, Victoria, occasional dead valves were found, but none alive. The first was hauled up in Bass Strait, among deep-sea animals and debris, and this was followed by other living specimens. The discovery of these living fossils must have excited as much interest at the time as did the finding of the first living coelacanth. It was as important from the scientific point of view.

The shells are placed in a separate family, the Trigoniidae, which includes a number of different genera, and many distinct species. Of these, only six are living to-day, and all are found along the Australian coast. Later research has revealed that the shells do occur as fossils in the Tertiary rocks of Australia, where alone they have persisted since Mesozoic time.

The present-day species are placed in the genus *Neotrigonia*. Because of their delightful lustre, the common name for them is brooch shells, and they are used for shell jewellery. The exterior of the shell is marked with a series of radiating ridges and nodules, and the hinge 'teeth' are large and strongly serrated; these features are characteristic of the group.

All the living species of *Neotrigonia* occur in fairly deep water, between 10 and 100 fathoms, and only dead shells are seen on the beaches after storms.

PHOSPHATE FERTILIZERS

In a recent publication* by the Organization for European Economic Co-operation, results of all suitable experiments in Western Europe that compare phosphate fertilizers made by processes which economize in sulphuric acid with other well-known phosphates have been collected and correlated by G. W. Cooke. The report is based on summaries of work carried out in their countries by *rapporteurs* from the Low Countries, Scandinavia, Austria, France, Germany, Italy, Portugal, Switzerland, Ireland and the United Kingdom. Occasional reference is made to comparable experiments in the United States.

The report emphasizes that the values of alternative phosphate fertilizers depend on the crops for which they are applied; unprocessed rock phosphates are satisfactory, for example, for swedes on acid soils, but potatoes make little use of this fertilizer and require water-soluble phosphates. The evaluation of fertilizers in both pot and field experiments is described, but most of the conclusions are based on extensive series of field experiments; results from 379 experiments with dicalcium phosphate and 537 experiments with phosphates produced by thermal processes are summarized in the report.

The main classes of phosphate fertilizers discussed are dicalcium phosphate, nitrophosphates, phosphates produced by high-temperature processes and compound fertilizers containing ammonium phosphates. Powdered dicalcium phosphate dihydrate is equivalent to superphosphate. Nitrophosphates that con-

* "The Agricultural Value of Phosphate Fertilizers which economize in the Use of Sulphuric Acid". By Dr. George W. Cooke, Rothamsted Experimental Station, Project No. 162. (Organization for European Economic Co-operation, Paris, 1956.)

tain a high percentage of water-soluble phosphate are also equivalent to superphosphate but those containing anhydrous dicalcium phosphate have not been fully evaluated and are tentatively rated as equivalent to three-quarters as much phosphorus in a water-soluble form. The better high-temperature phosphates, Rhenania phosphate and silicophosphate, are approximately equivalent to superphosphate for swedes and turnips, but inferior to superphosphate for cereals and grass. It is recommended that they should be used for purposes where high-soluble basic slag is suitable. Ammonium phosphates have generally given equivalent yields to superphosphate plus nitrogen fertilizer; on acid soils, monoammonium phosphate is sometimes inferior to mixtures containing superphosphate.

The report concludes with proposals for future investigations. The author emphasizes the need to compare the anhydrous and hydrated forms of dicalcium phosphate, and to study effects of the crystal form of this phosphate. The influence of other salts on the behaviour of dicalcium phosphate and the physical properties of granular fertilizers both require investigation. Further experimental work is also needed on the relationship between soil characteristics and the residual value of different phosphates, which has been inadequately studied, and on the conditions under which insoluble phosphates can be utilized in neutral and calcareous soils.

The detailed results on which the report is based have been deposited in several libraries, listed in an appendix, in most of the countries of Western Europe.

ANISOTROPIC THERMO-ELECTRIC EFFECTS IN GRAPHITE

By Prof. A. R. UBBELOHDE, F.R.S., and J. ORR

Department of Chemical Engineering, Imperial College of Science and Technology, London

WITHIN recent years the concept[1] that graphite presents a transition between aromatic and metallic electrons has been elaborated in a number of theoretical and experimental studies. Various considerations suggest that graphite is much more markedly metallic in one principal direction in the crystals, along the *a* axis, than perpendicular to this direction, along the *c* axis. Structurally, apart from lattice defects graphite presents infinite planes of conjugated aromatic electrons along the *a* axis, whereas along the *c* axis the macro-aromatic molecules are merely bound by van der Waals types of forces, with a distance of separation of around 3·35 A. This weaker interaction is accompanied by marked anisotropy of a number of physical properties related to the electronic interactions. Thus the thermal expansions are respectively $6{\cdot}6 \times 10^{-6}$ along the metallic and $26{\cdot}0 \times 10^{-6}$ along the non-metallic directions[2] in the crystals, compared, for example, with about 14×10^{-6} and 65×10^{-6} for zinc. The hardness is $> 6{\cdot}5$ Mohs along the *c* axis and about 0·5 Mohs along the *a* axis[3]. Relative rates of oxidation along the *a* axis and *c* axis are in the ratio[3] 17 : 1. Magnetic anisotropy is shown by the marked diamagnetism along the *c* axis[4]. Thermal conductance, which is mainly due to lattice vibrations, is about 4·0 watt cm.$^{-1}$ deg. C.$^{-1}$ along the *a* axis and 0·8 units along the *c* axis[5].

These differences are perhaps no larger than may be expected for anisotropic crystal structures generally. However, a new and striking group of phenomena appear when electronic properties are examined. The specific electrical resistance has been previously measured[5] and found to be about $3{\cdot}9 \times 10^{-6}$ ohm cm. along the *a* axis and about 0·01 along the *c* axis. It is most significant that the temperature coefficient of resistance along the *a* axis is metallic in character, and is about 0·009 deg. C.$^{-1}$, whereas along the *c* axis the crystals behave as semiconductors, with a temperature coefficient of $-0{\cdot}04$ deg. C.$^{-1}$. (Some theoretical interpretations[6] regard even the conductance along the *a* axis as of semiconductor type, but with zero activation energy.)

These findings lend particular interest to other anisotropic electronic properties of graphite. By courtesy of the Morgan Crucible Co., we have been able to cut appropriate sections from comparatively large blocks of material in which the alignment, though not perfect, is not far from that for single crystals. Using sections about 1·5 cm. long by 3 mm. square, it is readily shown that the thermo-electric power of graphite against copper along the *c* axis is about + 30 μV./deg. C. compared with about + 11 μV./deg. C. along the *a* axis.

Measurements of thermo-electric power against copper cannot be conveniently extended to very high temperatures, for various reasons. However, it is perfectly possible to measure the self thermo-electric power of graphite to quite high temperatures, by forming thermo-junctions between blocks cut along the *a* and *c* axes respectively. This has now been done. The blocks were mounted in electrical contact in impervious tubes of mullite with copper electrodes at the cold junctions, which were water-cooled. Various exploratory researches showed that above about 250° C. the presence or absence of even traces of oxygen had a critical influence on the self-e.m.f. (*a*/*c*) of graphite. Using 'B.O.C. white spot' nitrogen with less than 10 p.p.m. of oxygen to exclude air, the self-e.m.f. of graphite has been measured up to about 1,200° C. Temperatures were measured by chromel/alumel couples in the lower regions, and by pyrometry in the higher regions. Results up to about 700° C. are quite regular, and are illustrated in Fig. 1. Above this temperature, despite all precautions, a falling off in thermo-electric power was generally observed. There are reasons to believe that this falling off was due to adventitious oxidation, despite the protective stream of nitrogen, since values of thermo-electric power were occasionally obtained which lay on the prolongation of the curve at lower temperatures (not shown). Deliberate injection of oxygen into the nitrogen stream depresses the e.m.f. The point is possibly of some technical importance, since if the self thermo-e.m.f. of graphite in the complete absence of oxygen continues to follow

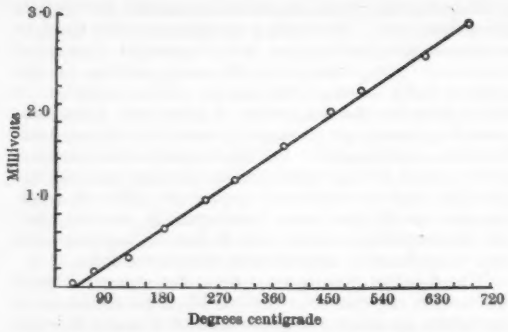


Fig. 1. Self thermo-e.m.f. of graphite, *a* block–*c* block

the low-temperature curve, then *a*/*c* combinations of graphite could form very useful thermo-electric junctions at very high temperatures. They might even be used for forming micro-power units in special circumstances.

Interpretation of these findings must necessarily be provisional at the present stage, but it accords with the general view, also based on other anisotropic properties, that graphite behaves as a metallic conductor along the *a* axis and as a semi-conductor with finite energy gap along the *c* axis. The fact that the *c* blocks are positive relative to the *a* blocks can perhaps be explained as follows:

The electronic levels along both axes may be represented as in Fig. 2*A*.

In the combination described, a '*c*' block/'*a*' block junction behaves like a semiconductor-metal contact,

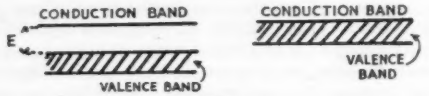


Fig. 2*A*

Fig. 2*B*

provided no *n*-type impurities are present in the '*c*' block to donate electrons to the vacant conduction bands or that there are few such centres compared with the number of electrons in the conduction band of the '*a*' block. The topmost filled levels of the '*a*' block will be higher than those of the '*c*' block. When contact is made, these levels will be adjusted until no difference exists.

As the temperature of the '*c*' block/'*a*' block junction is raised, electrons will flow from the '*a*' to the '*c*' specimen because the work function is less for the '*a*' specimen (Fig. 2*B*).

The thermo-electric power against copper shows that in both blocks the conduction appears to be mainly by means of holes in the valence band, with a greater number of holes for movement in the '*c*' direction than in the '*a*'. The origin of these holes need not be discussed here.

In the light of this tentative interpretation, the influence of oxygen is significant. It seems highly probable that oxygen attaches itself in the first instance to all defect sites and free valencies in the macro-aromatic molecules which form layers in the graphite crystals. As a result, at each group quinone electrons are withdrawn from the co-operative aromatic pool in each macro-molecule, in a manner well known when smaller aromatic molecules form quinones. This raises the work function of the macro-quinones in the planes of the macro-aromatic molecules so that the thermo-e.m.f. of '*a*' block against '*c*' block is reduced.

This interpretation of the effect of oxygen throws an interesting light on relative rates of oxidation along and perpendicular to the *a* axis, quoted above. The effect of oxygen on the thermo-electric power of graphite concords with previous interpretations of the effect of electron acceptors in lamellar compounds[7] as in bromine graphite.

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THE ALPHA HELIX IN NATURAL AND SYNTHETIC POLYPEPTIDES

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THE natural and synthetic polypeptides in the alpha form give two basic types of X-ray diagram. First, the X-ray diagrams of Bamford *et al.*[1a,b] from the simple synthetic polypeptides such as poly-L-alanine and poly-methyl-L-glutamate show a comparatively highly crystalline structure which can readily be indexed on a hexagonal lattice, involving only one chain per unit cell. A single chain in Fig. 1 shows a possible arrangement of the Pauling–Corey[2] helix as the basis of the screw along the fibre axis. Secondly, there is the more diffuse alpha diagram, found among the synthetic copolymers[3], the fibrous alpha protein molecules[4] and in certain cases the synthetic polymers made from identical monomers of large molecular weight, for example, poly-L-glutamic-benzyl ester[4]. The fibre diagrams from these specimens are more amorphous in character and the polar reflexions consist mainly of strong reflexions ~ 5·2 A.–~ 5·3 A. and ~ 1·5 A.; and a band of diffuse equatorial scatter varying in mean spacing from 9 A. to 12 A.

Chain displacement and the Pauling–Corey helix. It has been shown that the intense scatter on the 5·4 A. layer line of the X-ray diagram from the

symmetrical polypeptides is associated with the single turn of the helix[5]. It is therefore possible that an intense scatter would still be associated with this molecular repeat even if the individual chains are mutually displaced along the fibre or the side-groups of the amino-acid residues of differing molecular weight caused the helix to be distorted about its axis.

If the latter transformation is applied to the highly crystalline lattice structure, then the reflexions on the equator of the X-ray diagram showing hexagonal symmetry would be replaced by a diffuse band giving the mean distance of approach of the chains. Thus the more variable the side-chains the more diffuse would this reflexion become. In a comparatively crystalline protein such as porcupine quill, however, there appear to be several apparently unrelated equatorial reflexions, particularly 10·5 A. (v.s.), 9·22 A. (v.s.) and 7·5 A. (weak); in this case it is possible that discrete crystalline aggregates of differing average residue weights are present[6]. In less crystalline alpha proteins, such as wool and muscle, the reflexion is diffuse and has a mean value about 10 A.

Effect of molecular displacement parallel to the fibre axis. If displacement of molecules occurs in adjacent sheets parallel to the fibre axis (*b*), a further smearing out of the highly crystalline diagram may occur. The symmetry may be reduced to a form which would then give rise to (0*k*0) reflexions if[7] $(\Delta + \varphi) > \theta$ and capable of resolutions when $\Delta > \theta$ and $\varphi < (\Delta - \theta)$.

Thus Δ (max.), the angle between (0*k*0) planes and that normal to the fibre axis, would be approximately determined as shown in Fig. 1, where

$$\tan \Delta = h/2D \qquad (1)$$

that is, with a displacement of half the pitch of the helix (h) along the fibre axis, D being the mean separation of the chains. For the purpose of this discussion, (1) is an adequate approximation to the equation[7]:

$$\cos^2 \Delta = \frac{\sin^2 \beta - \cos^2 \alpha - \cos^2 \gamma + 2 \cos \alpha \,.\, \cos \beta \,.\, \cos \gamma}{\sin^2 \beta}$$

Thus the main polar reflexion on the fifth layer line, assuming a fibre repeat of 27 A., would be from the (050) planes and may in highly oriented samples be resolved into a doublet about the meridian. The spacing could therefore vary between $\sim d_{(0k0)} = h\cos(\tan^{-1} h/2D)$ as a minimum value, up to some value less than h, which would obtain when $\Delta \to 0$.

The 1·5 A. polar reflexion. In all the specimens, highly crystalline or otherwise, a polar reflexion of approximately 1·5 A. is present, due to the repeat of the amino-acid residue along the fibre axis. A maximum molecular displacement along the fibre axis will influence the spacing of this reflexion only slightly; for example, the maximum displacement would be 1·5 A./2 between identical positions in adjacent chains, thus the (0, 18, 0) spacing would change to a value of $1{\cdot}5 \cos(\tan^{-1} 0{\cdot}75/D)$. If $D \approx 10$ A., then $\cos \Delta = 0{\cdot}997$. The reflexion would therefore be only slightly smaller than that found in the synthetic polypeptides of the L-alanine types, but may in highly oriented samples be resolved about the meridian.

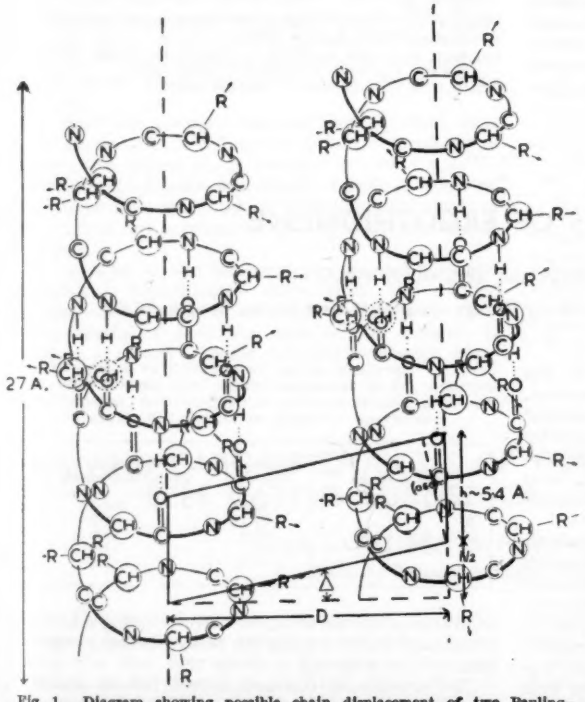

Fig. 1. Diagram showing possible chain displacement of two Pauling–Corey helices. The hexagonal symmetry of the alpha structures of the poly-L-alanine type is inhibited by this type of displacement, which has a maximum of half the length of a single turn of the helix parallel to the fibre axis

Application of displacement theory. There are four particular cases to which these considerations have been applied: (*a*) poly-L-glutamic-benzyl ester type of structure; (*b*) synthetic copolymers; (*c*) highly crystalline fibrous proteins; (*d*) normal alpha proteins.

In (*a*), one might have expected that the molecules would form a highly crystalline structure. Normally this is not the case, and on the X-ray diagrams the polar arc at ~5·3 A. can be resolved into a doublet about the meridian. It would appear that the large side-chains may influence the mutual displacement of the spiral molecules parallel to the fibre axis. It is, however, possible to recrystallize this fibrous structure into a more ordered pattern; but it does appear that the large and active side-chains play an important part in determining the packing of the chains. The copolymers of (*b*) generally are not very crystalline[4], showing an intense and diffuse reflexion of 10–12 A. on the equator and, as in (*a*), polar reflexions ~5·2 A. and ~1·5 A. In these polypeptides the side-chains cannot be symmetrically perpendicular to the helix for obvious reasons. Parallel to it the side-chain displacement and Δ may vary from polymer to polymer; this is shown in the small variations in the spacing of the (050) polar arcs[4].

The spacing variation in this polar reflexion has been a difficulty in the comparison between the synthetic polypeptides in which $d_{(050)} \approx 5{\cdot}25$ A. and that in proteins of 5·15 A. From this point it is of

interest to consider the polar arcs in the X-ray diagram of porcupine quill[6]. The reflexions can be identified as a polar arc of 5·15 A. (unresolved, since $\varphi > \theta$), spreading to a doublet of 4·9 A. on the same layer line. On stretching the fibre to its Hooke's Law limit, the 5·15 A. spacing can be increased to 5·25 A. (approximately that found in the synthetic polypeptides) with a consequent increase in the 4·9 A. spacing. It is possible, therefore, that the spacing variations between 5·15 and 4·9 A. may be related to a variation in the angle Δ due to chain displacement and particularly to variations in D of equation (1) in different components of the structure. The minimum value of $d_{(050)}$ would be $5{\cdot}25 \cos(\tan^{-1} 2{\cdot}6/7{\cdot}6) = 4{\cdot}9$ A. In the protein, the helical pitch is $\sim 5{\cdot}25$ A.; but Hooke's Law stretching can increase this to $\sim 5{\cdot}4$ A. of the synthetic polypeptides. It must be realized that the foregoing discussion assumes that the polar reflexions on the fifth layer line are from $(0k0)$ planes and do not involve reflexions from (hkl) planes with d_h and d_k forming a part of a larger unit of repeat perpendicular to the fibre axis.

In X-ray diagrams of unstretched porcupine quill where high resolution has not been obtained, the (050) spacing was[3] approximately 5·05 A. This diffuse reflexion may on these grounds comprise a superposition of the reflexions $(0k0)$, where $d_{(0k0)}$ may vary from 4·9 to a maximum value of about 5·15 A., and on stretching from 5·0 A. to 5·25 A.

In the keratin–myosin–epidermin–fibrinogen group of proteins of lower crystallinity than porcupine quill, the previous arguments may equally apply. On the X-ray diagram of keratin under tension, the diffuse polar arc is 5·15 A. in spacing, and this may be as low as 5·05 A. in unstretched protein fibres; but there appears little variation in the $\sim 1{\cdot}5$ A. spacing as would be expected. In these less crystalline proteins the helix may be distorted due to side-chain interaction (for example, cystine cross-links), causing an apparent small collapse of the helix along the fibre axis. The lattice can, however, be extended elastically to approximately that of the synthetic polypeptides. As in the other alpha polypeptides, chain displacement parallel to the fibre axis would have little effect upon the 1·5 A. polar spacing. It is hoped to study the effect of the random displacement of the chains in due course, but this is unlikely to cause much modification in the general thesis.

From this it is suggested that there is no reason why the helix of the highly crystalline synthetic polypeptides should not be similar basically to that in the proteins, and that the small variations in the spacings of their respective X-ray diagrams can possibly be explained. This discussion (outlined at the Australian Conference on Wool Technology, 1955) is based primarily on symmetry considerations of the Pauling–Corey spiral. It will in due course be necessary to consider its implications for the reflexion intensities of the diffuse protein pictures, particularly with reference to the coiled-coil structures of Crick[9], which may be difficult to apply to regenerated alpha protein structures. In its present form, however, it does give a possible correlation of the application of the Pauling–Corey helix to all the alpha polypeptides, both natural and synthetic.

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BIOSYNTHESIS OF ERGOTHIONEINE

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ERGOTHIONEINE was first discovered[1] in the sclerotia of the ergot fungus, *Claviceps purpurea*, but has since been found to occur in blood[2], semen[3] and various other mammalian tissues, principally liver and kidneys[4]. It does not appear to be biosynthesized by animals[5]. Conditions have been found, however, in which biosynthesis of ergothioneine occurs in shake cultures of *C. purpurea*[6,7].

This made possible the study of the biosynthesis of ergothioneine by radioisotope techniques. Through the incorporation of 2-^{14}C-acetate into ergothioneine by this fungus, it was shown[6,7] that the main contribution of acetate was in the provision of one-carbon fragments for the imidazole C-2 and the methyl carbons of the betaine. The five-carbon chain was not derived from glutamate. Histidine labelled with carbon-14 and isolated from the same growth showed a pattern of labelling almost identical with that in imidazolepropionic acid, the corresponding six-carbon compound derived from the biosynthesized ergothioneine. This is shown in Table 1.

Table 1. Comparison of the Distribution of Radioactivity in Histidine and in Imidazolepropionic Acid derived from Ergothioneine isolated from the Same Culture of *Claviceps purpurea* grown on a Medium containing 2-^{14}C-Acetate

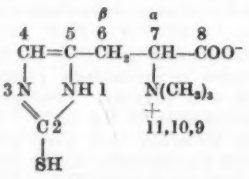
Carbon atoms	Radioactivity as percentage of total in: Histidine	Imidazolepropionic acid
2, 4, 5, 6, 7, 8	100·0	100·0
2	79·1	81·0
4, 5, 6, 7, 8	20·9	19·0
4, 5, 6, 7	12·7	11·7
8	8·2	7·3

The numbering convention (see below) which we have adopted[7] is the same as that used by Westley and Ceithaml[8] for histidinol.

Table 2. DISTRIBUTION OF RADIOACTIVITY IN ERGOTHIONEINE ISOLATED FROM CULTURES OF *Claviceps purpurea* GROWN ON MEDIA CONTAINING VARIOUS ^{14}C-LABELLED PRECURSORS

Carbon atoms	2-^{14}C-Acetate		7-^{14}C-Histidine (side-chain)		2-^{14}C-Histidine (ring)	
	Activity*	Percentage	Activity*	Percentage	Activity*	Percentage
2, 4, 5, 6, 7, 8, 9, 10, 11	4,476	100·0	14,220	100·0	6,900	100·0
9, 10, 11	1,500	33·5	0	0	82	1·2
4, 5, 6, 7, 8	565	12·6	14,301	100·6	0	0
2	2,411	53·9	0	0	6,554	95·0

* Total counts per min. at infinite thinness. Samples were counted as 1 sq. cm. areas of barium carbonate with an end-window Geiger–Müller tube and corrected for background, self-absorption, coincidence and variations in counting equipment.



We now wish to report briefly on the utilization of labelled histidine by *C. purpurea* for the biosynthesis of ergothioneine. The growth of the fungus on a chemically defined medium and the methods used for isolation and degradation of ergothioneine were essentially as described previously[7], except for the oxidation of formic acid. This was carried out with acid mercuric sulphate after distillation of formic acid from the acidified reaction mixture. α-^{14}C-histidine (side-chain) and 2-^{14}C-histidine (ring) were used in separate growth experiments and the distribution of isotope in the ergothioneine isolated from these cultures is shown in Table 2. Figures, which have been reported previously[7] for the isotope distribution in ergothioneine isolated from cultures grown in the presence of 2-^{14}C-acetate, are also given.

The results of the acetate and histidine experiments clearly show that ergothioneine is formed from histidine.

In previous communications[8] we reported that ergothioneine and histidine isolated from a culture of *C. purpurea* grown on a medium containing 2-^{14}C-histamine (ring) were completely inactive, showing that histamine, although a normal constituent of ergot[10], was not a precursor of ergothioneine in this fungus.

The results of the histamine (ring) and histidine (side-chain) experiments show that the fungus appears to be specific in its requirement for the five-carbon chain of histidine, and is not capable of utilizing a closely similar labelled imidazole compound without the appropriate side-chain. The acetate and histidine (side-chain) experiments did not establish the direct incorporation of the intact imidazole ring of histidine into ergothioneine. The possibility existed that ring fission could have occurred, followed by re-incorporation of a one-carbon compound linked through sulphur such as the —SCH$_3$ group of methionine.

During growth of the fungus on a medium containing 2-^{14}C-histidine (ring), a small amount of ring fission of the labelled histidine occurred, as slight activity was detected in the methyl groups of the betaine of ergothioneine. The very high labelling in the imidazole C-2 of this ergothioneine showed conclusively, however, that intact histidine had been incorporated into ergothioneine. The mechanism of the further steps involved, namely, sulphuration and N-methylation, is now being studied.

Melville[11] has reported briefly that radioactive ergothioneine is formed when *Neurospora crassa* is grown in the presence of labelled histidine.

Full details of this work will be reported elsewhere. We are grateful to Prof. C. Rimington for his interest in this work. We wish to thank Messrs. Burroughs Wellcome for a generous gift of ergothioneine and the University of London Grants Committee for the provision of equipment for radioactive counting.

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FILL AND CARCASS CHANGES OF YARD-FED AND OUTWINTERED BEEF CATTLE TURNED ON TO SPRING PASTURE

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CATTLE turned on to spring pasture commonly show losses in live weight or low rates of gain during the first few weeks. This check has been observed to be greater in yard-fed cattle than in those outwintered and has been reported under a variety of feed conditions[1]. In spring 1956 the effect was measured of four winter treatments on the live weight, fill and carcass weight of forty-eight Hereford-cross bullocks turned on to spring pasture.

During January–April four groups of twelve bullocks 2–2½ years old of similar initial mean weight were fed in separate lots. These four winter feeding treatments were designated, according to place and plane of feeding, 'yard high', 'yard low', 'pasture high',

Table 1. Gain in Live Weight and Calculated Warm Carcass Weight on Spring Pasture following Differential Winter Treatment

Winter treatment January–April 1956	Mean live weight April 25 (lb.)	Gain in weight on spring pasture (lb. per head)					
		April 25–May 16		May 16–June 6		Total in six weeks	
		Live weight	Carcass weight	Live weight	Carcass weight	Live weight	Carcass weight
Yard high	1,122	5	32	64	34	69	66
Yard low	949	68	49	87	42	155	91
Pasture high	1,100	10	24	89	47	99	71
Pasture low	996	75	46	82	52	157	98
No. of bullocks per treatment	12	8		4			

'pasture low'. Silage, hay and straw were fed in weighed quantities from the same source to yard and pasture groups. The high-plane group received a greater proportion of silage to straw than the low-plane group, and a daily supplement of 6 lb. per head of crushed oats. Little grazing was available on the holding paddock for the pasture groups until grass growth began in March. The yard groups were sheltered in a cattle yard with a high roof. The approximate mean live-weight gain from January to April was 1¼ cwt. for the high groups and ¼ cwt. for the low groups.

An initial slaughter sample of four bullocks was taken from each of the four winter treatments on April 25 and 27, 1956. The remaining thirty-two bullocks were turned together on to a cocksfoot-dominant grass/clover ley, with the winter treatment groups equally divided between two spring managements, strip grazing and rotational grazing. After three weeks, a second slaughter sample, two from each treatment combination, was taken. The remaining sixteen bullocks were grazed for another three weeks before slaughter on June 6 and 8. At each date, the same procedure was followed. After weighing from the field or yard at four hours after sunrise[2], the sample bullocks were slaughtered about three hours later. Total contents of stomachs and intestines were weighed, and the measured loss in live weight on the journey to the abattoir was added. This gave a figure for weight of fill at four hours after sunrise.

The live-weight changes followed the pattern already observed in yard-fed and outwintered cattle, but were smaller than in some years. After turning on to spring pasture the mean live weight of all groups fell, reaching its lowest point after 4–6 days; in this period the loss ranged from 54 lb. per head for yard high to 2 lb. per head for pasture low. The weights increased from this point to show a live-weight gain of 5–75 lb. in the first three weeks, the low groups gaining much more than the high (Table 1). Live-weight gains in the second period were high, some exceeding 4 lb. per day. Total gain was higher in the low groups than in the high.

Table 2. Weight of Fill at Four Hours after Sunrise
Treatment mean, lb. per head*

Winter treatment 1956	Slaughter 1 (from winter feed) April 25 and 27	Slaughter 2 (from pasture) May 16 and 18		Slaughter 3 (from pasture) June 6 and 8	
		Strip	Rotation	Strip	Rotation
Yard high	184	130	148	178	144
Yard low	170	142	166	185	165
Pasture high	159	167	117	180	166
Pasture low	167	170	142	201	162
No. of bullocks per treatment	4	2	2	2	2

* Treatment means are adjusted by covariance to allow for differences in initial weight of bullocks.

At the first slaughter, the yard groups gave a slightly, but not significantly, higher mean weight of fill than the pasture groups (Table 2). The latter were by this time obtaining a proportion of their feed from grazing, were refusing straw and eating less hay. The second slaughter sample showed that, in general, there was a loss of fill after three weeks on spring pasture. The fill of the low groups at this second slaughter was on average 15 lb. higher ($0{\cdot}05 < P < 0{\cdot}1$) than that of the high groups.

This could have been due to a higher rate of pasture intake by these bullocks following a low winter plane of feeding. At the third and final slaughter in June, weights of fill were higher than in May, and of the same order as those in April. Strip grazing gave a higher mean fill ($0{\cdot}01 < P < 0{\cdot}05$) than rotational grazing. The higher weight of fill in these cases may be partly explained by increasing 'stemminess' of the herbage in the second three-week period, particularly evident under the strip management.

From the dressing-out percentage of the slaughter sample, the carcass weights of bullocks remaining after each slaughter were calculated, to make possible an estimate of their subsequent carcass gains. The high groups showed a carcass increase of 24 lb. and 32 lb. per head, in the period when their live-weight gains were 10 lb. and 5 lb., respectively (Table 1). Gains were only slightly greater in the second three weeks than in the first. In rate of carcass gain over six weeks there was little difference between yard and pasture groups. The low groups, however, gained 40 per cent more than the high groups. Their carcass gains confirm the findings of many authors, for example, Hughes *et al.*[3], that rapid live-weight recovery follows periods of low nutrition.

The patterns of live-weight change observed in this experiment can be explained in terms of both fill losses and carcass gains. The big changes in fill suggest that the economic importance of spring live-weight losses may be over-estimated, although severe scouring may give a greater check to carcass gain than was observed in this experiment. Such large fill changes are important in evaluating live weights of experimental stock. Fæcal analyses suggest that both the fibre content in the ration and the rate of intake are related to fill. Further work is planned on these and other factors which may contribute to such losses, and full results will be reported elsewhere.

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LETTERS TO THE EDITORS

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Activation of Amino-acids by Soluble Enzymes from Pancreas and Other Tissues

LAST year, Hoagland[1] reported that he had obtained from rat liver a soluble enzyme preparation which catalysed the formation of amino-acid hydroxamates when incubated with a mixture of twelve amino-acids in the presence of adenosine triphosphate and hydroxylamine. He suggested that this type of carboxyl group activation might be a first step in protein synthesis. In a later paper with Keller and Zamecnik[2] he reported partial purification of activating enzyme from liver.

We were able to repeat the work of Hoagland *et al.*, and having regard to the possible importance of these enzymes for protein synthesis we examined the distribution of amino-acid - activating enzymes in several mammalian tissues. Enzyme activity was estimated by measuring the amount of amino-acid hydroxamate formed from a mixture of twelve amino-acids as described by Hoagland, Keller and Zamecnik[2]. The enzyme preparation was the supernatant obtained by centrifuging a homogenate of tissue (1 part) in 0·05 *M* potassium chloride (1·5 parts) at 100,000 *g* for 45 min. Results are given in Table 1.

Table 1. RELATIVE ACTIVITY OF DIFFERENT TISSUE EXTRACTS IN ACTIVATION OF AMINO-ACID CARBOXYL GROUPS

Tissue	Hydroxamate formed (μmole/mgm. protein/hr.)
Rat liver	0·03
Rabbit liver	0·02
Guinea pig liver	0·03
Chicken liver	0·02
Rat kidney	0·01
Rabbit kidney	0·02
Guinea pig kidney	0·01
Chicken kidney	0·02
Rat pancreas	0·04
Guinea pig pancreas	0·05
Rabbit muscle	0·02
Guinea pig muscle	0·02
Guinea pig gut	0·04

From these results, it was clear that amino-acid - activating enzymes are widely distributed in mammalian tissues and that pancreas was likely to be a good raw material for further purification.

It was found that an active enzyme could be obtained from guinea pig pancreas by dilution of the centrifuged supernatant with twelve times its own volume of 0·05 *M* potassium chloride, adjustment of the *p*H to 4·8 and centrifugation. The precipitate was redissolved in *tris*hydroxymethylaminomethane buffer at *p*H 7·6 and tested for its ability to activate single amino-acids or groups of chemically related amino-acids; the results are shown in Table 2.

From these results, it was clear that guinea pig pancreas was rich in enzymes activating serine or threonine and histidine or tryptophan. Tests on the individual amino-acids showed that the *p*H 4·8 enzyme activated serine, threonine and tryptophan but was inactive towards histidine.

By fractionation with ammonium sulphate, the enzyme activating serine and threonine could be partially separated from that activating tryptophan.

Table 2. ACTIVATION OF AMINO-ACIDS BY *p*H 4·8 ENZYME FROM GUINEA PIG PANCREAS

Amino-acid	Hydroxamate formed (μmole/mgm. protein/hr.)
Valine + leucine + isoleucine	0·008
Serine + threonine	0·010
Arginine + lysine	0·003
Histidine + tryptophan	0·030
Methionine	0·005
Phenylalanine	0·007
Mixture*	0·104

* The complete mixture contained alanine, valine, leucine, isoleucine, phenylalanine, threonine, serine, histidine, arginine, lysine and tryptophan.

Starting with the *p*H 4·8 enzyme, serine–threonine activation was predominant in protein separated between 0·35 and 0·55 saturation with ammonium sulphate (0·125 μmole/mgm./hr. for serine and threonine and 0·09 μmole/mgm./hr. for tryptophan), while the protein precipitated between 0·55 and 0·8 saturation was mainly tryptophan-activating enzyme (0·19 μmole/mgm./hr. for tryptophan and 0·06 μmole/mgm./hr. for serine and threonine).

Working on a larger scale, it has been possible to use sheep or ox pancreas and to prepare a stable acetone powder. By ammonium sulphate fractionation of an extract of this powder, an enzyme preparation has been obtained which is specific for L-tryptophan, stable to dialysis and which requires magnesium ions and adenosine triphosphate.

It seems likely from the results of Keller and Zamecnik[3] that these amino-acid - activating enzymes play a part in protein synthesis, but the distribution of enzyme activity towards different amino-acids seems to be characteristic of the type of tissue used as source of enzyme; thus, Hoagland, Keller and Zamecnik[2], using rat liver, found a quite different distribution of activity from that shown in Table 2; moreover, Demoss and Novelli[4] reported that a similar enzyme preparation from micro-organisms showed no activity towards serine or threonine.

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Competitive Inhibition of Mammalian Tyrosinase by Phenylalanine and its Relationship to Hair Pigmentation in Phenylketonuria

IN Jervis's introductory study, and in subsequent case reports of phenylketonuria (phenylpyruvic oligophrenia), a blonde hair colour and a fair skin have been noted in the large majority of the patients[1–4]. The most striking example described by Jervis was "an idiot baby with blonde hair and blue eyes who belonged to a family of Sicilian extraction, all the members of which, for at least three generations, were of a very dark Mediterranean race"[1]. Three possible hypotheses may be advanced to explain the reduction of melanin formation: absence of the melanin-forming enzyme, tyrosinase; absence or decrease of the melanin precursor, tyrosine; and

finally, inhibition of the tyrosine–tyrosinase reaction by phenylalanine or related abnormal aromatic metabolites which accumulate in the blood of patients with phenylketonuria.

That the latter explanation is the most likely is suggested by recent reports of the darkening of hair colour in patients with phenylketonuria who were maintained on synthetic diets deficient in phenylalanine[2–4]. The blonde colour may, therefore, result from the reversible inhibition of tyrosinase located in the melanocytes of the hair bulb by abnormal concentrations of phenylalanine, phenylpyruvic acid and phenyllactic acid. Darkening of the hair is associated with return of blood—and presumably tissue—phenylalanine-levels to normal in patients maintained on the diet. Furthermore, a recent study by Dancis and Balis has revealed that L-phenylalanine partially inhibits the oxidation of tyrosine by tyrosinase obtained from plant sources[5]. Since plant tyrosinase is much less specific in its action than mammalian tyrosinase, it is preferable to study the effect of phenylalanine and other intermediates which accumulate in phenylketonuria on the mammalian tyrosine–tyrosinase reaction. We have now shown that phenylalanine, phenylpyruvic acid and related metabolites are inhibitors of mammalian tyrosinase.

Mammalian tyrosinase was prepared from the Harding–Passey melanoma as described previously[6]. Tyrosinase activity was determined manometrically by measurement of oxygen uptake in the Warburg apparatus at 38° C. with 0·1 *M* sodium phosphate buffer at *p*H 6·8. When acid was used as an inhibitor, *p*H was adjusted to 6·8 by addition of sodium hydroxide. Each Warburg vessel contained 1·4–1·5 units of tyrosinase[6] in the side arm. The substrates, 0·4 mgm. of L-tyrosine or 0·5 mgm. of L-dihydroxyphenylalanine, were contained in the main chamber with various amounts of compounds studied with a total volume of 2·8 ml. of reaction mixture. Each experiment was carried out at least in duplicate.

As shown in Table 1, L-phenylalanine has an inhibitory effect on the enzymic oxidation of tyrosine and dihydroxyphenylalanine. After studying by Lineweaver and Burk's method of plotting[7], L-phenylalanine was found to be a competitive inhibitor of tyrosine–tyrosinase activity.

Inhibition of mammalian tyrosinase by L-phenylalanine at the same concentration as in the blood of patients is about 15–30 per cent under the experimental conditions described. However, both enzyme (tyrosinase) and substrate (tyrosine) are present in the human skin and hair follicle in much smaller amounts. Therefore, greater inhibition by L-phenylalanine can be expected *in vivo*.

Table 1. Inhibition of the Oxidation of L-Tyrosine and L-Dihydroxyphenylalanine by Mammalian Tyrosinase

	Total molarity (*M*)	Inhibition (per cent) L-Tyrosine	L-Dihydroxyphenylalanine
L-Phenylalanine	0·001	15	8
	0·005	37	29
	0·01	51	37
Phenylacetic acid	0·001	7	
	0·005	14	
	0·01	20	
Sodium phenylpyruvate	0·0001	2	
	0·001	10	
	0·005	36	
	0·01	50	
p-Hydroxyphenylacetic acid	0·0001	23	
	0·001	38	
	0·005	80	
	0·01	91	
D-Phenylalanine	0·0043	0	
	0·0087	3	
DL-Alanine	0·0025	0	
	0·0082	0	

Competitive inhibition of the tyrosine to melanin reaction by phenylalanine at the melanocyte-level is further suggested by darkening of the blonde hair in phenylketonuria following the oral administration of large amounts of tyrosine[8]. By supplying an excess of tyrosine, the normal ratio of the inhibitor (phenylalanine) to metabolite (tyrosine) is restored and normal melanin formation results.

The effects on the tyrosine–tyrosinase reaction of several other compounds which were reported to occur in the blood or to be excreted in the urine of the phenylketonuric patient are also presented in Table 1. Phenylpyruvic acid (sodium salt) and phenylacetic acid were found to be weak inhibitors of mammalian tyrosinase, whereas *p*-hydroxyphenylacetic acid has the most marked inhibitory effect. In addition, D-phenylalanine and DL-alanine failed to show any significant inhibitory effect even at relatively high concentrations of $8{\cdot}7$ and $8{\cdot}2 \times 10^{-3}$ *M*, respectively.

The other abnormal metabolites reported to occur in this disease also might play a part in the decrease of pigment formation; but their concentrations in the blood are very low and significant effect cannot be expected. For example, the level of phenylpyruvic acid in the blood of patients was reported to be $0{\cdot}31$–$1{\cdot}78$ mgm. per 100 ml. ($1{\cdot}89 \times 10^{-5} - 1{\cdot}09 \times 10^{-4}$ *M*)[9], and at this range practically no inhibition was observed as shown in Table 1. Therefore, it is concluded that the increased L-phenylalanine is the most important factor responsible for the phenylketonuric hypopigmentation, and the other abnormal metabolites have only slight influence on melanin formation.

The fact that the D-isomer of phenylalanine has no inhibitory effect on the tyrosine–tyrosinase reaction is evidence of the importance of the steric configuration of the inhibitor.

According to Harper *et al.*[10], the levels of phenylalanine in the blood of normal individuals vary from 1·1 to 4 mgm. per 100 ml. ($6{\cdot}7 \times 10^{-5} - 2{\cdot}4 \times 10^{-4}$ *M*), and at the highest concentration of this range enzymic inhibition occurs. It is suggested that phenylalanine be considered as one of the factors controlling normal melanin formation.

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Effect of Antimetabolites on Antigen *Vi* Synthesis and Variability in *S. typhi*

S. typhi grown at 18° C. fails to produce antigen *Vi* and is immune to *Vi* phages[1]. We submitted such a culture of *S. typhi* to the influence of various factors, transferred it into 37° C., and studied in suitable media the synthesis of antigen *Vi*, growth of the bacteria and synthesis of cell protein (Mazia)[2]. We determined antigen *Vi* in hot saline extracts by passive hæmagglutination[3-5].

Bacteria inhibited by chloromycetin retained their ability to produce antigen *Vi* (curve 1), though they failed to synthesize protein or to grow. There are data indicating that the enzyme responsible for synthesis of antigen *Vi* exists in the cells at a temperature of 18° C. over a number of generations in spite of absence of actual synthesis of the antigen.

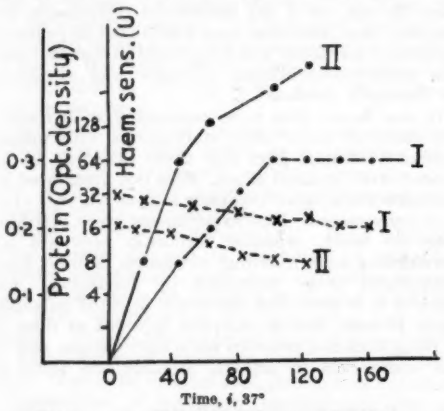

Fig. 1. —.—, *Vi* antigen; – – . – –, cell protein

Examination of growth-inhibiting factors demonstrated that all those inhibiting respiration or reducing cell metabolism and suppressing the Krebs cycle inhibit at the same time antigen *Vi* synthesis at 37° C. This effect is exerted by cyanides, malonic acid, vacuum, absence of oxygen (evacuation or flushing with inert gases) and, finally, by high concentrations of dinitrophenol. Chloromycetin and lethal doses of ultra-violet radiation, on the other hand, fail to inhibit antigen *Vi* synthesis (Table 1). The effect on antigen *Vi* synthesis of malonic acid was examined in particular. Bacteria originally sensitive to 0·065 *M* malonic acid are easily adapted to 0·025 *M* malonic acid by consecutive passages in increasing concentrations. Already in 0·01 *M* concentrations of the acid (in the second passage) the bacteria fail to synthesize antigen *Vi*.

Table 1. INFLUENCE OF VARIOUS FACTORS ON ANTIGEN *Vi* SYNTHESIS

Factor	Antigen *Vi*
Acriflavin 0·5 per cent	Absent
Acriflavin 0·1 per cent	Absent
Dinitrophenol 0·005 *M*	Present
Dinitrophenol 0·01 *M*	Present
Dinitrophenol 0·025 *M*	Absent
Malonic acid 0·005 *M*	Present
Malonic acid 0·010 *M*	Present
Malonic acid 0·025 *M*	Absent
Potassium cyanide 0·005 *M*	Absent
Vacuum	Absent
Carbon dioxide	Absent
Ultra-violet irradiation	Present
Chloromycetin	Present
Control	Present

In higher concentrations they grow as a sediment on the bottom of the vessel. Centrifuged and transferred into fresh media, the micro-organisms are lysed almost completely within 0–30 min. (from optical density 0·3 to 0·02). Plating of a thick suspension grown in 0·25 *M* malonic acid produces only a few dozen colonies from 1 ml. The factors responsible for lysis of the bacteria grown in a malonate medium are not yet known. The possible presence in the cells of a prophage seems unlikely to be the cause, in view of the rapid rate of lysis. The few surviving micro-organisms yield a large percentage (20–40 per cent) of colonies producing no antigen *Vi* and immune to *Vi* phages, but still susceptible to typhus *O* phages.

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Late Effects of Gamma Radiation on Mice protected with Cysteamine or Cystamine

THE short-term value of cysteamine (β-mercaptoethylamine) and its disulphide (cystamine) as protective agents against whole-body irradiation is now well established[1]. Little is known, however, about the ultimate fate of the survivors from the radiation syndrome. This communication is concerned with the induction of lymphosarcoma and lymphatic leukæmia by cobalt-60 in *C* 57 *BL*/6 mice protected with one of these substances.

A total of 553 mice of both sexes, aged 38 ± 3 days, was randomly assigned to four treatment groups receiving different total doses in two exposures five days apart. Before each exposure, mice of the protected group received an intraperitoneal injection of cysteamine (3 mgm./10 gm.) or a gastric instillation of cystamine (4 mgm./10 gm.). Irradiated mice of the control group similarly received saline. In two other control groups, mice received cysteamine or cystamine but were not irradiated. The 50-day protection afforded by these compounds under the experimental conditions was significant[2].

Evaluation of the long-term protection, however, has brought up other problems. Survivors in all groups have been observed for a period of 300 days after the first exposure. Incidence of tumours in all groups has been tabulated (Table 1). In the group receiving 703 r. total dose, seven mice died prematurely from a late post-irradiation infectious and necrotic process. Numerous disseminated and confluent caseous lesions were found in lungs, liver and kidney. Therefore results on tumours from this group are not statistically significant. In the group receiving 301 r. total dose, the percentage of tumours approached the level expected in the controls. According to Kaplan[3], the threshold for tumour induction by single exposure to X-radiation is about 283 r. At both other dose-levels, however, incidence

Table 1. Incidence of Tumour among *C* 57 *BL* Mice surviving Radiation Death

Group	Total dose	Initial No. of mice	Survivors after 60 days	No. of tumours	Deaths from other causes	Tumours (per cent)
Saline	301 r.	40	23	1	1	4
	406 r.	50	20	3	3	15
	550 r.	78	43	8	3	18
	742 r.	60	9	2	4	22
	Control	24	24	0	2	0
Protected by cysteamine	301 r.	40	27	2	0	7
	406 r.	40	23	6	1	26
	550 r.	66	44	16	2	36
	742 r.	45	15	1	5	7
	Control	24	24	0	1	0
Protected by cystamine	550 r.	50	31	9	1	29
	742 r.	24	8	3	1	38
	Control	12	12	0	1	0

of tumours in protected mice was significantly higher than in unprotected mice.

This result is in sharp contrast with the observed inhibition of tumours in irradiated *C* 57 *BL* mice protected by bone-marrow injection and thigh or spleen shielding[4]. A cocarcinogenic effect of cysteamine or cystamine has been postulated. No such effect, however, could be demonstrated after 300 days in *C* 57 *BL* mice painted with methylcholanthrene and given daily 10 mgm. of cystamine in the drinking water for three months (Mewissen, D. J., unpublished results).

Since evidence is now accumulating that human leukæmia may follow acute or chronic exposure to radiation and also extensive radiotherapy, these observations are important for the clinical application of chemical protective agents.

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Reserpine and Serotonin in Experimental Convulsions

It has been postulated that serotonin plays an important part in the maintenance of normal activity in the central nervous system, and that drugs causing some profound disturbances in its activity, for example, lysergic acid diethylamide, function through their anti-serotonin action[1].

It has been shown that reserpine and serotonin have some central actions in common (potentiation of hypnotics) which are blocked by lysergic acid diethylamide[2], and that reserpine liberates serotonin from its body depots, including the brain[3,4]. Accordingly it has been suggested that the central actions of reserpine are mediated through serotonin released in the brain[5]. This hypothesis, however, can be accepted only if it is possible to demonstrate that all central actions of reserpine are mimicked by serotonin.

We have therefore endeavoured to verify whether serotonin plays a part in the facilitating action of experimental convulsions manifested by reserpine. The principles and procedures followed were in all regards the same as previously described[6]. Two convulsant drugs, camphor and leptazol, were injected endoperitoneally in albino mice, and convulsant doses ED_{95}, ED_{50} and ED_5 have been calculated, and found to be (mgm./kgm.): for camphor 205·0, 120·0 and 70·0; for leptazol 145·0, 98·0 and 66·0.

Reserpine at a dose of 30 mgm./kgm. was injected subcutaneously in albino mice 3 hr. before the convulsant drug; serotonin at a dose of 20 mgm./kgm., or 500 mgm./kgm. of 5-hydroxy-tryptamine-creatinine-sulphate, was injected subcutaneously in albino mice 15 min. or 2 hr. before the convulsant drug. Camphor and reserpine were solubilized as previously reported; serotonin was solubilized in distilled water. The serotonin-creatinine sulphate was synthesized by Bernini's method[7].

It was found that mice pretreated with reserpine and camphor show tonic convulsions with maximal extension of hind legs like those observed in mice treated with leptazol alone. Mice not pretreated with reserpine show, after camphor injections, only clonic-type convulsions. The experiments were planned in order to verify whether serotonin provokes tonic convulsions with maximal extension of hind legs or counteracts those provoked by reserpine. From Table 1 it is seen that serotonin injected subcutaneously 15 min. before camphor injected at dose ED_5 or ED_{95} does not provoke tonic convulsions, and does not counteract in all the animals the tonic con-

Table 1. Convulsant Activity of Camphor and Leptazol in Mice
Tonic convulsions (maximal extension of hind legs) have been registered only

Reserpine (subcutaneous)		Serotonin (subcutaneous)		Convulsant drug (intraperitoneal)		Mice convulsing to mice injected
Dose (mgm./kgm.)	Time before convulsant	Dose† (mgm./kgm.)	Time before convulsant	Compound injected	Dose (mgm./kgm.)	
—	—	—	—	Camphor	70·0 = ED_5	0/20
30	3 hr.	—	—	,,	70·0 = ,,	6/20
—	—	20	15 min.	,,	70·0 = ,,	0/20
30	3 hr.	20	15 min.	,,	70·0 = ,,	5/20
—	—	500	15 min.	,,	70·0 = ,,	0/20
30	3 hr.	500	15 min.	,,	70·0 = ,,	1/20
—	—	—	—	,,	205·0 = ED_{95}	0/20
30	3 hr.	—	—	,,	205·0 = ,,	14/20
—	—	20	15 min.	,,	205·0 = ,,	0/20
30	3 hr.	20	15 min.	,,	205·0 = ,,	11/20
—	—	500	15 min.	,,	205·0 = ,,	0/20
30	3 hr.	500	15 min.	,,	205·0 = ,,	6/20
—	—	—	—	Leptazol	66·0 = ED_5	0/20
—	—	—	—	,,	145·0 = ED_{95}	18/20
30	3 hr.	—	—	,,	66·0 = ED_5	20/20
—	—	20	15 min.	,,	66·0 = ,,	0/20
30	3 hr.	20	15 min.	,,	66·0 = ,,	16/20
—	—	500	15 min.	,,	66·0 = ,,	1/20
30	3 hr.	500	15 min.	,,	66·0 = ,,	16/20
—	—	20	2 hr.	,,	66·0 = ,,	0/20
30	3 hr.	20	2 hr.	,,	66·0 = ,,	15/20
—	—	500	2 hr.	,,	66·0 = ,,	0/15‡
30	3 hr.	500	2 hr.	,,	66·0 = ,,	2/18§
Vehicle for reserpine*		20	15 min.	Camphor	70·0 = ED_5	0/20
Vehicle for reserpine*		20	15 min.	,,	205·0 = ED_{95}	0/20
Vehicle for reserpine*		20	15 min.	Leptazol	66·0 = ED_5	1/20

* Injected subcutaneously 15 min. before convulsant.
† All values are in terms of 5-hydroxy-tryptamine-creatinine-sulphate.
‡ 5 mice out of 20 died after serotonin.
§ 2 mice out of 20 died after serotonin.

vulsions provoked by reserpine. As the partial protective action is afforded only by very high doses of serotonin, the significance to this effect is not clear.

Also, in animals treated with leptazol at dose ED_{s}, the serotonin, injected subcutaneously 15 min. or 2 hr. before the convulsant drug, does not provoke any tonic convulsions (maximal extension of hind legs) and does not counteract the facilitating action of reserpine in all the injected animals. Since this counteraction was observed at very high dose, but only in some of the animals treated, it seems impossible in this case also to give proper significance to this fact.

These results do not support the hypothesis that the central action of reserpine is mediated through the serotonin released in the brain. Indeed, if the facilitating action on convulsions manifested by reserpine were mediated in this way, it seems quite logical to expect exogenous serotonin to have the same facilitating action. Additional facilitating action might be expected if the free serotonin flooding the cells of the brain is augmented by endogenous serotonin released by reserpine plus the injected exogenous serotonin.

In the experiments of Brodie *et al.* the exogenous serotonin has the same action as endogenous serotonin. In the experiments reported here the exogenous serotonin only augments the calming and depressant effects of reserpine.

On the other hand, if the cells of the brain deprived of their normal amount of serotonin by reserpine were more susceptible to action of hypnotics or convulsant drugs, then the injected exogenous serotonin should have counteracted the facilitating action of reserpine. The results reported here, obtained with very high doses of serotonin, are not very significant. It may be recalled that Brodie *et al.*[4] showed the impairment of serotonin binding-sites due to reserpine, which could explain the partial failure of exogenous serotonin to modify the facilitating action of reserpine.

It seems impossible to explain this failure by supposing that serotonin fails to reach the central nervous system, since the calming effect of serotonin and the potentiating activity versus calming effect of hypnotics and reserpine, can take place only in the cells of the brain.

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Immunochemical Heterogeneity of Human Plasma Lipoproteins

EVIDENCE for the immunochemical heterogeneity of human plasma lipoproteins has recently been presented[1]. Several lipoprotein fractions and a non-lipoprotein containing plasma protein fraction were isolated from human plasma by ultracentrifugal methods. Antiserums against lipoproteins were prepared in rabbits. No cross-reaction was observed between anti-lipoprotein serums and the non-lipoprotein-containing plasma protein fraction. By serological absorption of the antiserums, high-density lipoproteins (hydrated density 1·07–1·16 gm./ml.) were found to be distinguishable from low-density lipoproteins (hydrated density less than 1·063 gm./ml.). Differences were observed between the quantitative precipitin behaviour of two low-density lipoprotein fractions, S_f 6 (hydrated density, 1·03–1·04 gm./ml.) and S_f 13 (hydrated density, 1·015–1·03 gm./ml.), and their respective antiserums. By the Oudin agar diffusion procedure[2], six to eight bands were observed in tubes. Band formation did not, however, proceed in the usual manner. Rather, the formation of a precipitation zone was observed first, and then, within this zone, bands developed.

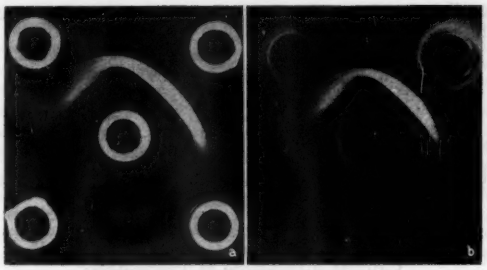

Fig. 1. (*a*) Agar diffusion plate, five weeks after start of diffusion. Centre well contained human serum; the outer wells contained the following amounts of precipitable anti-lipoprotein antibody of the euglobulin fraction of rabbit anti-S_f 6 lipoprotein serum: upper right, 0·05 mgm.; upper left, 0·03 mgm.; lower right, 0·01 mgm.; lower left, 0·005 mgm. The agar mixture consisted of 2 per cent agar, 0·9 per cent sodium chloride, 0·003 per cent methyl orange and 0·002 per cent merthiolate. Human serum and antiserum fractions were diluted in agar to contain the same final agar, sodium chloride and merthiolate concentrations. (*b*) The same plate as in (*a*), three weeks later, after it was stained with sudan black *B*. Six bands are distinguishable, all staining with the lipid stain

This type of band formation had not previously been described; also, there are reports in the literature suggesting that human plasma lipoproteins are homogeneous by the criterion of agar diffusion[3,4]. We proceeded, therefore, to examine our systems by the Ouchterlony modification of the agar diffusion procedure[5].

Fig. 1,*a* is a photograph of an agar diffusion plate five weeks after start of diffusion. The centre well contained an agar whole human serum mixture; the outer wells contained a mixture of agar and several concentrations of the euglobulin fraction *E*-6 of an anti-S_f 6 lipoprotein rabbit serum[1]. At an intermediate antibody concentration (0·03 mgm. of antibody in the well), five bands were clearly evident on the plate, although the limitations of photographic reproduction made them difficult to illustrate here. Fig. 1,*b* is a photograph of the same plate, three weeks later, after the plate had been stained with sudan black *B*. (We wish to thank Dr. Lawrence Levine for suggesting details of the procedure.) All precipitation bands were stained black, while precipitation bands in control plates containing non-lipoprotein systems did not stain. Similar results, that is, the formation of several precipitation zones, all staining with lipid stains, were also obtained with isolated lipoprotein fractions, and with other anti-lipoprotein serums and serum fractions.

It is concluded that human plasma lipoproteins are immunochemically heterogeneous by the criterion of agar diffusion on plates. The study of these immunochemically different lipoprotein components

and their relationship to pathogenesis of disease[6] will be an interesting challenge.

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Motile Catalase-producing Strains of *Lactobacillus delbrückii*

The characteristics of the lactic fermentation-inducing bacteria used for lactic acid production in several industrial plants in Czechoslovakia known under the name *Lactobacillus delbrückii* have been investigated. Several significant differences from the description of this species in Bergey's "Manual" have been found, though the fermentation of sugars and the production of lactic acid were in accord with the data given. A surprising catalase content, however, has been revealed.

Quantitative catalase determination by means of the Warburg respirometer[1] has shown a catalase content in all the strains investigated. The catalase quotient has been found to be 2,000 at *p*H 7 and at the incubation temperature 37° C., so that it is near *Escherichia coli* (2,100). Besides catalase the spectrophotometric investigation revealed the presence of cytochrome *a* and *b*. The cytochrome *c* zone was indistinct. The presence of the hæmatin pigments has been checked by the inhibitory effect of potassium cyanide on glucose oxidation.

The purity of the strains has been checked by means of the dilution method, by isolation from one cell and by means of a selective culture medium. It has been concluded that the observed differences in the enzymatic systems of the strains studied, disagreeing with the usual descriptions of *Lactobacillus delbrückii*, can be in no case explained by an infection or lack of homogeneity of the strain.

It is assumed that the strains investigated are similar in their characteristics to *Thermobacterium cereale* as described by Davis[2]. In text-books *Thermobacterium cereale* is usually erroneously considered to be a synonym for *Lactobacillus delbrückii*.

Contrary to the characteristics commonly ascribed to the genus *Lactobacillus* we have observed flagella in two of the strains. The only observations of this phenomenon in the literature are those by Harrison and Hansen[3] in *Lactobacillus plantarum* var. *mobilis*, by Mann and Oxford[4] in three unstable cultures of *Lactobacillus* isolated from the rumens of calves and by Cunningham and Smith (quoted from Tittsler *et al.*[5]) in the *Lactobacillus* isolated from silage. Electron microscopic observation has revealed long flagella (Fig. 1) in young cells 7–9 hr. old from two of the three strains investigated. In the third strain no flagellum could be found.

Fig. 1. Electronmicrograph of *Lactobacillus delbrückii* from 48° C., 8 hr., malt agar culture, showing flagella. (× *c.* 18,500)

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Host Infection in *Pellicularia filamentosa* controlled by Chemical Stimuli

Pathogenic specificity of different strains of the fungus *Pellicularia filamentosa* (Pat) Rogers to different host plants has been shown by Flentje[1] to be determined at two distinct stages in the infection process. One of these stages is on the external surface of the host stem before penetration occurs. The hyphæ of a pathogenic strain become attached to the cuticle of a susceptible host above the junction of epidermal cells, grow in a characteristic manner along the stem following the lines of junction of these cells, and form complex appressoria or 'infection cushions'. Each infection cushion is produced from a side branch in which normal elongation has ceased but in which further prolific side branching has occurred. Infection takes place only from these cushions. Strains not pathogenic to the host fail to become attached to or organize on the stems. Flentje[1] suggested that this differential reaction may be due to a diffusible chemical exudation from the host.

The first direct evidence of stimulation of *P. filamentosa* by chemical exudates from seedlings was presented by Kerr[2] using a 'Cellophane' bag technique. This work has been extended by us, using several distinct strains of the fungus and three types of seedling—radish, tomato and lettuce. In several tests there was a close correlation between the susceptibility of the seedlings to the pathogens and the stimulation of the pathogens by the seedlings. It was apparent that a root excretion was causing this differential stimulation of growth of the different strains. Most strains of *P. filamentosa* cause a damping-off of seedlings, the roots of which are not attacked by the fungus, but it was thought that excretions

might be present also on stems and be responsible for specificity in attachment and penetration.

The work was extended by studying the action of radish root excretions *in vitro*. Surface-sterilized radish seeds were germinated on distilled-water-agar and after 2 days 300 seedlings were transferred to washed sterilized sand, where they grew for 7 days. Root excretions were obtained by removing the seedlings, expressing the solution from the sand through 'Cellophane' in a pressure membrane apparatus (Richards[3]) and evaporating it down to 0·4 ml. by vacuum distillation. The resultant solution was bio-assayed by adding 0·005 ml. to filter-paper disks 4 mm. in diameter, placing these on small islands cut in distilled-water-agar in a Petri dish and covering the surface with sterilized 'Cellophane' disks, approximately 8 cm. diameter. The top of the 'Cellophane' was inoculated in different plates with three different strains of *P. filamentosa*, one of which was pathogenic to radish. The strains grew out over the 'Cellophane' and that pathogenic to radish showed a marked response on the 'Cellophane' covering the filter-paper disks soaked in root exudate, while the other strains failed to respond. The response of the radish strain was evident in the side branches of hyphæ in which normal elongation ceased and further prolific side branching occurred, to give a clumping similar to the infection cushions on radish stems (Fig. 1, *a* and *b*). Nutrients such as glucose-peptone broth when tested in the same way failed to show any of these characteristic effects on growth although they gave a general increase in density of hyphæ.

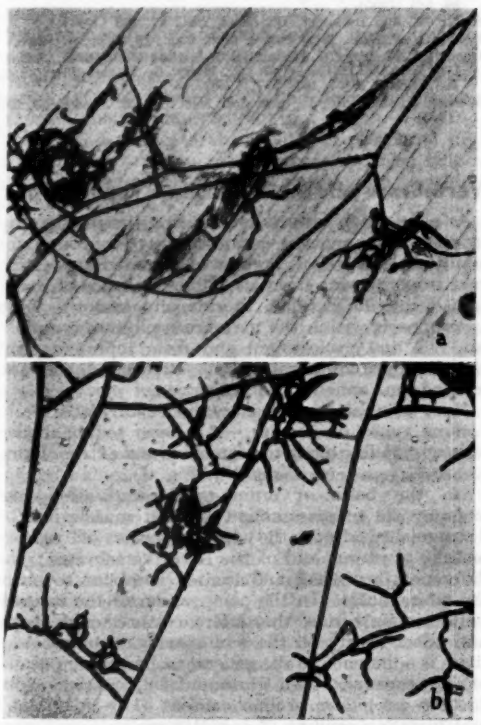

Fig. 1. Growth of the radish strain of *P. filamentosa*—*a*, on a radish seedling prior to penetration; and *b*, on 'Cellophane' over radish root excretions

However, as no penetration of the 'Cellophane' ever occurred in response to the root exudate, and as the radish strain organizes on and penetrates stems and not roots, it seemed that the nature of the surface on which organization occurred might also be important in bringing about penetration. Radish seedlings from which strips of epidermis and cuticle had been removed or which had been punctured in several places by fine (10μ diameter) glass needles were inoculated with the radish strain of *P. filamentosa*. Both treatments increased the number of infection cushions produced, these structures being formed not on the exposed cortical cells, but on the cuticle immediately alongside such cells, and penetration was always through cuticle and epidermis, never through the wounded tissues. The presence of cuticle appeared to be important for attachment and penetration.

Epidermal strips approximately 15 mm. × 3 mm. were then obtained from radish seedlings and placed, cuticle facing upward, on similar-sized strips of distilled-water-agar to which 0·01 ml. of root exudate had been added. Small blocks of agar inoculum of the three strains were placed alongside these epidermal strips so that the hyphæ grew out over them. The hyphæ of the radish strain became attached to the cuticle above the junction of the epidermal cells, grew along the lines of junction of these cells, formed infection cushions and penetrated the strips as on living stems. On control strips of radish epidermis with no root exudate present, attachment and growth along the lines of junction of cells occurred but no infection cushions were formed and no penetration took place. The two other strains tested in this way with radish root exudate failed to form infection cushions on, or penetrate, epidermis stripped either from radish or from the hosts to which they are pathogenic.

It appears, then, that attachment to, organization on, and penetration of a host by the radish strain of *P. filamentosa* is controlled by the nature of the cuticle surface, and the presence of a diffusible material which is excreted on to the cuticle surface from the underlying cells. Specificity of reaction of the different strains to different hosts is probably due to variation from host to host of the nature of the cuticle surface, and of the diffusible excretion.

This evidence for chemical stimulus of penetration is at variance with the widely accepted theory proposed by Brown[4] that the penetration stimulus is non-specific and due to physical contact. Most previous work on penetration has been carried out with airborne parasites in which there would be little selective advantage in responding to chemical stimuli from a host, as the only chance of survival of a spore lies in penetration of the substrate on which it has lodged. For soil-borne pathogenic fungi such as *P. filamentosa* there would appear to be a definite selective advantage in reacting only to chemical stimuli from susceptible plants, thus increasing the chance of survival in the competition for nutrients in the soil.

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Colominic Acid, a Substance of Bacterial Origin related to Sialic Acid

Some years ago, it was found that a mucoprotein derived from submaxillary mucin contained an acidic component which was termed sialic acid[1]. More recently, it has been shown that other mucoproteins of mammalian origin contain substances closely related to sialic acid; among these are neuraminic[2], gynaminic[3] and lactaminic[4] acids. Despite intensive chemical investigations, the structure of these various substances has not yet been fully elucidated.

During an investigation on the nature of colicine *K*, an antibacterial agent elaborated by a strain of *Escherichia coli* known as *K*-235[5], a substance was encountered in the culture medium which had properties similar in many respects to those of sialic acid. This substance has been termed colominic acid.

Crude colicine and colominic acid may be precipitated from a culture medium in which *Escherichia coli K*-235 has been grown, by adding ethanol at 0° C. (75 per cent)[6] to the concentrated and dialysed solution. Following dialysis, the two substances can be separated by precipitating the colicine at *p*H 5·8 with ammonium sulphate (85 per cent). Colominic acid is isolated from the supernatant, after dialysis, by freeze-drying (yield: 1 gm. from 15 l. of culture medium).

Colominic acid is obtained as a snow-white amorphous powder. It is devoid of serological activity and is homogeneous when examined by electrophoresis. It gives only feeble anthrone and biuret tests, and tests for hexosamines, pentoses, and hexuronic acids are negative. Colominic acid dialyses very slowly through 'Cellophane', and an aqueous solution of the free acid has a *p*H of 3·7. Upon heating with dilute mineral acid, colominic acid rapidly forms humin. When heated with Ehrlich's reagent, it gives a red colour, and a reddish-purple colour is formed when the substance is heated with Bial's reagent. Colominic acid itself does not reduce Benedict's solution, but after autoclaving an aqueous solution, reducing substances are liberated.

Colominic acid has the following analysis: C, 46·80; H, 5·82; N, 4·54; CH_3CO, 15·10. It has an optical rotation in water of $[\alpha]_D^{20°} = -50·5°$. Methoxyl groups, sulphur and phosphorus are absent. The neutral equivalent is 326. From the analytical data the formula $[C_{12}H_{18}NO_{8-9}]_n$ would appear to represent most closely the polymeric form of colominic acid. Each unit is believed to contain one acetyl and one carboxyl group.

Although colominic acid possesses properties which relate it to sialic acid, it shows differences as well. The absorption maximum of the red colour produced by colominic acid in the Ehrlich test lies at 530 mμ whereas that of sialic acid is at 565 mμ. The absorption coefficient of the two substances at 530 mμ is identical; at 565 mμ, however, that of colominic acid is slightly lower. Sialic acid gives a positive Bial reaction when tested under conditions described by Werner and Odin[7], but colominic acid does not. Finally, it should be said that colominic acid is an amorphous macromolecular material whereas sialic acid is a crystalline substance.

The fact that sialic and colominic acids show closely related absorption spectra in the infra-red region also attests to similarities in their structures (we are greatly indebted to Dr. Herbert Jaffe of this Institute for the spectral measurements). It will be seen from

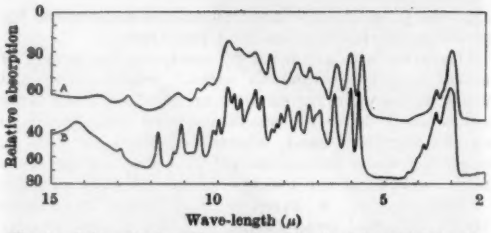

Fig. 1. Infra-red adsorption spectra of colominic acid (*A*) and of sialic acid (*B*). Measurements were made using 1-mgm. samples of each compound compressed in a potassium bromide pellet

Fig. 1 that the spectral bands of the two substances show excellent conformity at the shorter wavelengths. At longer wave-lengths, however, this is not the case. Because of the amorphous and polymeric nature of colominic acid, broadening of its spectrum in this region is to be expected.

In sum, a substance of relatively high molecular weight is elaborated by the micro-organism *Escherichia coli K*-235, which bears a close relationship to sialic acid. This substance has been termed colominic acid. Its exact biochemical function is at present unknown, but it is hoped that future work will elucidate this point.

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Vertebrate and Invertebrate Tropomyosins

As a first step toward generalizing the relationship between tropomyosin, actin and myosin found for rabbit skeletal muscle[1], we have prepared and examined tropomyosins from the different types of mammalian muscle (cardiac, uterine and smooth), from lower classes within the vertebrate phylum (amphibian, fish and cyclostome) and from representatives of different invertebrate phyla (arthropod, mollusc, echinoderm, annelid and nemertian).

Most of these proteins crystallize in plates or in various types of needles. All have sedimentation constants falling along the same line and extrapolating to an $S_{20,w(c=0)}$ of about 3·0 (Fig. 1).

On the basis of amino-acid composition, the tropomyosin of mammalian striated muscle can be distinguished from the tropomyosins of smooth muscle, of uterus and of the lower vertebrates; the differences are small and limited to about seven of the amino-acids. In the composition of the invertebrate tropomyosins; the differences are much larger and affect nearly all the amino-acids; nevertheless, there is adherence to the general tropomyosin pattern of, for example, high glutamic acid content (160–200/10^5 gm.), low proline content (1·6–10/10^5 gm.) and histidine content (3·4–13/10^5 gm.).

Although within the several phyla studied, practically every amino-acid seems susceptible to

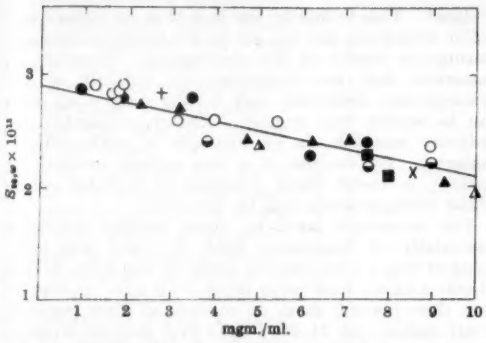

Fig. 1. Sedimentation of tropomyosins prepared from various animals. ▲, Rabbit skeletal; ●, bovine bladder; ■, rabbit uterine; Δ, flatworm; ×, earthworm; +, lobster; ◒, Venus foot; ○, L-meromyosin (ref. 3). These results show that L-meromyosin (rabbit) closely resembles tropomyosin in its sedimentation behaviour

alteration from class to class, one apparent regularity stands out. The sum of these basic groups is always about $140/10^5$ gm., and in the lower phyla arginine replaces some of the lysine. Similar observations have been made on molluscs by Bailey[2] and Yoshimura[5]. In vertebrate striated muscle, lysine is 107 and arginine $41/10^5$ gm.; in lobster, lysine is 83 and arginine $56/10^5$ gm.; in molluscs, lysine is 74 and arginine $62/10^5$ gm.; and in annelids, lysine is 56 and arginine $83/10^5$ gm.

Another finding concerns the total charge of these molecules. Although the basic groups remain constant, a decrease in dicarboxylic acid content together with a higher amide ammonia results in a lower net anionic charge in the lower phyla. Thus at neutral *p*H the vertebrates and sea cucumber have 80–90 charges/10^5 gm., lobster and squid about $70/10^5$ gm., and the annelids about $30/10^5$ gm.

These data indicate that the lysine–arginine distribution and total anionic charge of a given tropomyosin can be correlated with the phylum to which the animal belongs.

An apparent exception to these regularities was found when squid tropomyosin was compared with the tropomyosin found to be abundant in clam smooth-muscle adductor[2]; the latter had a low net charge and inversion of its lysine and arginine values compared with squid. Ammonium sulphate fractionation of clam tropomyosin yielded a main fraction (about 80 per cent) precipitating between 28 and 40 per cent saturation, termed here tropomyosin *A*, and a second fraction precipitating between 45 and 65 per cent saturation, termed here tropomyosin *B*. Tropomyosin *B* has the same lysine and arginine values as squid tropomyosin, and approximately the same charge.

This seems to be the first time that two tropomyosins have been isolated from a single muscle. It appears that tropomyosin *B* corresponds to the tropomyosins found in other animals. Because of its abundance and because of the small amount of myosin which can be isolated from clam muscle, tropomyosin *A* appears to be part of the contractile system in clam adductor muscle.

Attempts in this laboratory to isolate such a second tropomyosin from rabbit skeletal myosin have been made recently in the light of evidence[4] that mammalian tropomyosins contain two free —SH groups per molecule. Performic acid oxidation of purified myosin gives in the product a mixture of two peaks on ultracentrifugal analysis, one sedimenting similarly to tropomyosin and a slower one similarly to depolymerized actin. Purification so far has enriched the tropomyosin content to 70 per cent; amino-acid analysis of this product corresponds to a mixture of 30 per cent of actin and 70 per cent of a tropomyosin which is much richer in phenylalanine and histidine and much poorer in alanine than free tropomyosin. It appears, therefore, that a tropomyosin *A* is also present in rabbit muscle as a constituent of the contractile system.

Detailed accounts of this work will be published elsewhere.

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A Basal-Cell Carcinoma in the Fowl

In birds, though sarcomata are well known, carcinomata appear to be extremely rare[1]. The literature contains few references to these, one of the most recent being to that reported in a Pennant's parakeet[2]. In the course of work in this department a small flat tumour about 1 cm. across was noted at autopsy in a Brown Leghorn capon between the right ear and the angle of the jaw. Feathers, apparently normal for that site, were distributed over the area of the tumour. The growth, together with the surrounding skin, was sectioned in a plane normal to the surface. Upon histological examination the tumour was found to be a typical basal-cell carcinoma. This diagnosis was kindly confirmed for us by Prof. R. A. Willis. Within the growth carcinomatous cells could be seen to be invading the mesodermal cores of feather papillæ, as shown in Fig. 1. We owe to

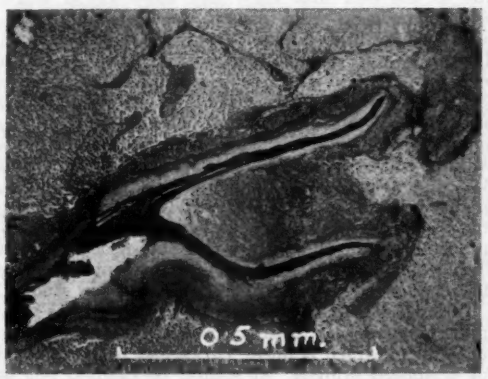

Fig. 1. Section of tumour, normal to the surface, which is to the left. The growth is seen invading the papilla of a small feather

Prof. Willis the suggestion that this carcinoma may in fact be derived from basal-cells of a feather-germ.

The bird was nine years old and had in previous years been used in work involving the administration of œstrone. This had been given in four intradermal injections into the breast, each of 0·05 mgm., in alcohol, spread over a period of six months. It had also been given a dose of 500 r. X-irradiation directed to a patch about 2 cm. × 3 cm. on the back of the neck just below the base of the skull and so just posterior and rather median to the site of the growth. The radiation was of approximately 1·25 mm. aluminium half-value layer and the focus-skin distance was 10 cm.

Our sincere thanks are due to Mr. T. J. Tulley, who, with the kind permission of Dr. K. W. Beetham, administered the radiation in the Radiotherapy Department of the Hull Royal Infirmary.

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Inaccuracy of Anaphase Bridges as a Measure of Radiation-induced Nuclear Damage

One of the most significant contributions that led to the development of the target theory in regard to chromosome aberrations was Sax's observation[1] that X-ray-induced dicentrics and rings, which require two breaks or hits, increase as the square of the dose. There have been numerous reports in the literature, however, of a linear dose curve resulting from the scoring of anaphase bridges that ostensibly come from the dicentrics and rings. Even Sax himself has reported in a paper by Sax and Brumfield[2] such a linear one-hit curve in the seed of *Vicia faba*. Later, Wolff[3] found that if the metaphase configurations in *Vicia* were scored, the theoretically important parabolic two-hit curve was obtained. The differences in these two curves were attributed to many diverse phenomena. Wolff thought that the difference between his curves and those of Sax and Brumfield might be due to the fact that they may have scored single bridges resulting from one-hit isochromatid breaks, rather than the double bridges associated with dicentrics and rings. Caldecott[4,5], however, in a series of papers in which he obtained the linear curve for anaphase bridges in barley, observed that the bridges were all double, and postulated that the apparent contradiction between Sax's and Wolff's two-hit curves on one hand, and Caldecott's and Sax and Brumfield's one-hit curves on the other, might be due to differences in hydration of the material[5]. Since the two-hit curve is of very great importance for the theory of the production of chromosome aberrations, it is important that the discrepancy in the two types of curves be studied.

In order to test this discrepancy observations were made both of metaphase and anaphase in barley, the material in which a linear curve had been reported for anaphase bridges. It should be pointed out at this time that the scoring of metaphase aberrations is far more satisfactory than the scoring of anaphase bridges[6]. This is due to the fact that at metaphase, unlike anaphase, one can see all the chromosomes and distinguish nearly all the aberrations. However, in materials that are comparatively difficult to use cytologically, anaphase may be the only stage that can be scored very readily. Barley, if handled by ordinary methods, is an example of such difficult material. By the use of a new squash method for barley[7], however, large numbers of scorable metaphase configurations can be obtained.

The technique used in these studies consisted essentially of irradiating both dry and wet seeds (soaked 8 hr.) with various doses of 250 kVp. X-rays (1,000 r./min., half-value layer 0·55 mm. of copper) and then placing them on moistened filter paper in Petri dishes. At 24–26° C. the first mitotic divisions of barley root tips usually occur about 24 hr. after beginning of germination. Consequently, after 20 hr. the seeds were removed from the filter paper and placed on filter paper that had been soaked with a 0·2 per cent colchicine solution and were then allowed to germinate further on the colchicine. This treatment destroyed the spindle and allowed all the dividing cells to accumulate at metaphase. The seeds were then fixed in a mixture of 6 parts absolute alcohol, 3 parts chloroform and 1 part acetic acid and stored overnight at 60° C. in the fixative. After an 8-min. Feulgen hydrolysis the seeds were stained in leuco-basic fuchsin and treated with a 5 per cent pectinase (obtained from Nutritional Biochemicals Co.) solution for about 2 hr. Those root tips in which anaphases were studied were not treated with colchicine but otherwise underwent identical treatment. For each point of the dose curves, 300 cells were scored from a total of six slides.

In Fig. 1 it may be noted, both in the dry and in the hydrated seeds, that if dicentrics and rings are scored at metaphase the theoretically expected two-hit curve is obtained, that is, the dicentrics and rings increase as the square of the dose. However, if only anaphase bridges are scored it is found that they increase linearly with dose. These are all double bridges such as would be expected from dicentrics and rings. The difference, therefore, is not due to the bridges being the result of isochromatid aberrations as was once postulated, or to the differences in hydration, since this occurs in both dry and soaked seeds. At present all that can be said is that the discrepancy seems to be some sort of an artefact that appears when anaphase bridges are scored. We

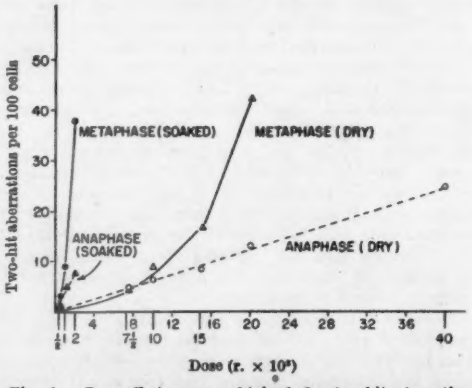

Fig. 1. Dose-effect curves obtained for two-hit aberrations when metaphase and anaphase are scored

do not know what causes this. Most phenomena which could prevent dicentrics and rings from making observable bridges —as the two centromeres going to the same pole in such a manner that the two chromatids fall apart, or non-disjunction occurring by which one of the centromeres drags the other centromere up to the same pole—would be expected to occur in a constant proportion of cases regardless of dose. One would, therefore, not expect to obtain a linear one-hit curve but a two-hit curve, increasing as the square of the dose but somewhat less rapidly than the original metaphase curve.

Another very important point in this case is that the metaphase curve which, of course, is assumed to show more accurately the amount of nuclear damage, has no constant relation to the anaphase curve. At low doses, nearly as many aberrations will be scored at anaphase as at metaphase, whereas as the dose increases, the discrepancy between the two curves becomes greater and greater. This means, of course, that anaphase results do not give a very accurate indication of the amount of nuclear damage. Consequently, one has to use great care in correlating other radiation effects to nuclear damage as measured by anaphase bridges.

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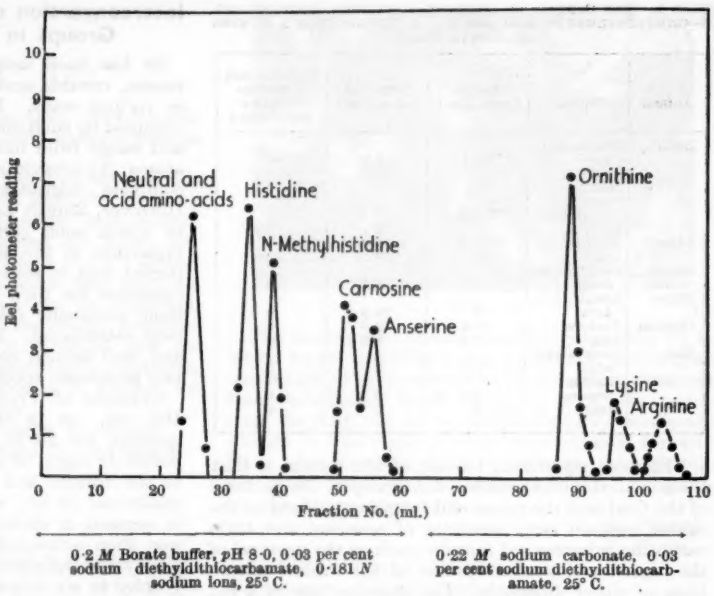

Fig. 1. The fractionation of basic amino-acids and the dipeptides carnosine and anserine by buffered elution from a 50 cm. column 0·9 cm. diameter, packed with 'Dowex-50' resin, 4 per cent cross-linked. The preparation and running of such a column have been described (refs. 1,2). A photometric ninhydrin method was used to estimate the amino-acids (ref. 7)

An Ion Exchange Method of determining Carnosine, Anserine and their Precursors in Animal Tissue

ALTHOUGH elegant procedures have been described for the separation of the neutral and acidic amino-acids by elution from sulphonated polystyrene resins, the quantitative separation of the basic amino-acids has proved more difficult[1,2]. For example, when the *p*H of the eluting buffer is more than 7 their recoveries rarely exceed 80 per cent. It is for this reason that buffers of *p*H less than 7 and relatively high sodium ion concentration have previously been used in their separation, although such conditions greatly reduce the sensitivity of the method.

In general, the separation of amino-acids containing groups of closely similar *p*K value is greatest when the *p*H of the eluting buffer is 1–2 units higher than the *p*K of the group controlling the cation exchange with the resin[3], which in the case of the basic amino-acids is the weaker of the two basic groups present. This communication mainly describes the separation of amino-acids containing an imidazole nucleus, that is, histidine, N-methylhistidine, carnosine and anserine, in which the imidazole *p*K controlling the exchange varies from 6·00 for histidine to 7·04 for anserine. Optimal separation of amino-acids within this narrow range of *p*K should therefore be achieved by using a buffer between *p*H 8 and 9 and by manipulating the cationic strength to give a low distribution ratio. Unfortunately, it is precisely in this range of *p*H that the recovery falls most drastically, and it is suggested that these losses may be due to traces of heavy metals in the resin material forming a complex with the amino-acid. This is borne out by the fact that complete recoveries are obtained when powerful chelating agents are added to the buffers. As sodium diethyldithiocarbamate is found to be most effective for this purpose, it is likely that the contaminating ions are copper. Once the yield has been improved in this way, the sodium ion concentration can be adjusted to give convenient eluting volumes. The final method adopted is shown in Fig. 1.

The method has been used for examining the levels of carnosine and anserine and of the precursors, histidine and N-methylhistidine, in the muscles from various animal species. The results are summarized in Table 1. Samples of muscles were prepared as soon as possible after the death of the animal so that the possibility of any hydrolysis of the dipeptides was reduced to a minimum[4].

Table 1. The Content of Anserine, Carnosine, Histidine and N-methylhistidine of Red and White Muscles from a Number of Animal Species

Animal	Muscle	Anserine (μmol./gm.)	Carnosine (μmol./gm.)	Histidine and N-methyl-histidine (μmol./gm.)
Rabbit	Longissimus dorsi	19·3	3·2	0
	Psoas	21·8	2·3	0
	Heart	0	0	0
	Semi-tendinosus	Trace	0	0
	Liver	0	0	0
Pigeon	Pectoral	4·4	1·0	0
	Leg	0	0	0
Sperm whale	Longissimus dorsi	4·9	9·1	0
Horse	Longissimus dorsi	0	25·5	0
Chicken	Pectoral	43·5	12·3	0
	Leg	7·4	2·2	0
Rat	Longissimus dorsi	8·9	3	0
	Gastroc-nemius	6·7	0	0
	Heart	0	0	0

The most significant feature of the results is that the so-called white muscles, for example, the pectoral of the fowl and the psoas and longissimus dorsi of the rabbit, contain large amounts of anserine and little carnosine, whereas red muscles such as the pectoral of the pigeon and semitendinosus of the rabbit contain little of either dipeptide. The extreme case of a red muscle is, of course, the heart, which is better supplied with blood than other muscles. Rat and rabbit heart contain no detectable amounts of carnosine or anserine. The longissimus dorsi of the horse is exceptional in having a high level of carnosine, but no anserine, while the considerably whiter muscles of the rat contain little anserine and almost no carnosine. There is a relatively low concentration of the dipeptides in the longissimus dorsi of the sperm whale. In no case are the precursors histidine and N-methylhistidine present in detectable amounts. It is interesting that the peak which contains the neutral and acidic amino-acids (Fig. 1) is 8–10 times larger in muscles containing little or no carnosine and anserine than for muscles rich in these dipeptides. The high concentration of these amino-acids in muscles such as rat heart is of the same order as the concentration of the dipeptides in white muscle such as rabbit psoas.

The results, which are particularly interesting in view of the recent importance attached to carnosine and anserine in both aerobic and anaerobic glycolysis[5,6,8], are being followed up with a detailed study of the intermediary metabolism of these dipeptides.

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Interconversion of 17-Keto and 17β-Hydroxyl Groups in Steroids by Protozoa

It has been amply demonstrated that bacteria, yeasts, moulds and actinomycetes convert steroids in various ways. In many instances, the products obtained by such microbial action have been identified and range from modifications at one or two carbon atoms (hydroxylation, dehydrogenation, etc.) to a complete degradation of the steroidal molecule[1]. However, almost nothing is known about the ways in which such compounds are affected by micro-organisms of the animal kingdom. It has been reported that in some cases Protozoa require steroidal materials for their subsistence[2], but the identity of their metabolic intermediates or products has not been established. We wish to report that a specific and well-defined reaction can be brought about by two protozoan species of the genus *Trichomonas*.

Cultures of *Trichomonas gallinae* were grown in 100 ml. of a trypticase – serum – thioglycollate medium for 24 hr. at 37° C. At the end of this period 10 mgm. of the steroid to be tested was added to the culture and the incubation continued for an additional 24 hr., either under anaerobic conditions or aerated in shaken flasks. The steroidal material was then extracted from the culture medium with methylene chloride and identified by paper chromatography in six solvent systems[3].

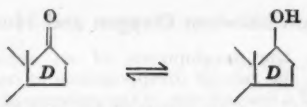
The results indicated that all the 17-ketosteroids tested were reduced to their corresponding 17β-hydroxy analogues in an anaerobic environment, and that a reversal of such reductions occurred under aerobic conditions (Table 1).

Table 1. Conversions of Steroids by *Trichomonas gallinae* 10 mgm. of steroid dissolved in 1 ml. propylene glycol/100 ml. medium. One-day growth and one-day conversion at 37° C.

Reaction	Substrate	Product
Reduction	4-Androstene-3,17-dione	17β-Hydroxy-4-androsten-3-one
	4-Androstene-3,11,17-trione	17β-Hydroxy-4-androstene-3,11-dione
	1,4-Androstadiene-3,17-dione	17β-Hydroxy-1,4-androstadien-3-one
	11α-Hydroxy-4-androstene-3,17-dione	11α,17β-Dihydroxy-4-androsten-3-one
	11β-Hydroxy-4-androstene-3,17-dione	11β,17β-Dihydroxy-4-androsten-3-one
	3β-Hydroxy-5-androsten-17-one	5-Androstene-3β,17β-diol
	3β-Acetoxy-5-androsten-17-one	3β-Acetoxy-5-androsten-17β-ol + 3β-Hydroxy-5-androsten-17-one + 3β-Hydroxy-5-androsten-17β-ol
	Œstrone	Œstradiol
Oxidation	17β-Hydroxy-4-androsten-3-one	4-Androstene-3,17-dione
	11β,17β-Dihydroxy-4-androsten-3-one	11β-Hydroxy-4-androstene-3,17-dione
	17β-Hydroxy-4-androstene-3,11-dione	4-Androstene-3,11,17-trione
	17β-Hydroxy-4-œstren-3-one	4-Œstren-3,17-dione

In addition, the bioconversion product of 4-androstene-3,11,17-trione was isolated by column chromatography and identified as 17β-hydroxy-4-androstene-3,11-dione (11-ketotestosterone) by mixed melting point with the corresponding authentic steroid and by infra-red analysis. No transformations by this organism of Δ^4-3-keto-pregnene derivatives were detected.

These results show that the trichomonad contains a dehydrogenase which carries out a specific interconversion of the 17-keto and 17β-hydroxyl groups in C_{18} and C_{19} steroids:



We have observed that another trichomonad (*T. foetus*) also brings about specific transformations of this type.

The interconversion of keto- and hydroxy-steroids occurs in a variety of mammalian tissues[4]. In many instances, bacteria[5], yeasts[6], moulds[7] and actinomycetes[8] have also been reported to affect the oxygenation of C_{18} and C_{19} steroids in the 17- as well as the 3-positions. Our findings show that reactions of this type can also be carried out by Protozoa.

Further work will be published elsewhere. Acknowledgment is made to Mr. L. M. Reineke and his associates for the paper chromatographic analyses, and to Dr. J. L. Johnson and Mrs. G. S. Fonken for the infra-red spectrographic data.

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Isolation of Melanin Granules

THE study of melanin granules is of both commercial and academic importance in the investigation of the pigmentation and bleaching of animal fibres. A means of separation of the granules from the keratin matrix which leaves them morphologically and chemically unaffected is therefore desirable. The methods of isolation which have so far been used consist in dissolving the keratinous material either by acid or alkaline hydrolysis, or by treatment with a mixture of phenol hydrate and thioglycollic acid. Of these, the last[1,2] appears to be the most satisfactory, because it leaves the granules undamaged. It is, however, extremely laborious, involving refluxing of the protein substance for twenty-four hours, after which the resultant suspension is centrifuged for 10 hr.

By refluxing melanin-containing protein with 60 per cent w/v hydrazine/absolute alcohol solution for 2 hr., using a liquor ratio of 50 : 1, it has been found possible to isolate the pigment granules. The protein is converted into hydrazides of low molecular weight[3,4] and any undispersed matter is filtered out on a coarse filter paper, through which the granules pass. The suspension is centrifuged for 2 hr. at 2,000 *g*, the supernatant liquor is decanted off and the residual granules are washed three times with distilled water.

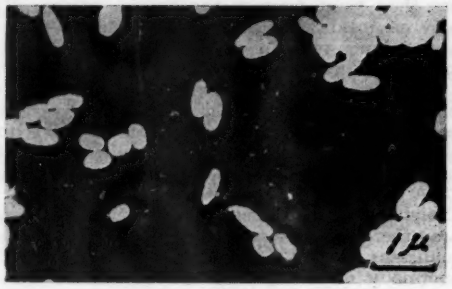

Fig. 1

The accompanying electron micrograph (Fig. 1), for which we are indebted to Dr. J. Sikorski, shows granules which have been isolated by the above treatment from dark-brown Welsh mountain wool. As may be seen, they appear to be morphologically unaffected, though in this instance they were refluxed for 4 hr. Even after digestion for 2 hr., however, the granules are quite clean, and no advantage is to be gained by the longer treatment.

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Interatomic Bonding in Manganese Trifluoride

THE monoclinic unit cell of manganese trifluoride has dimensions a, 8·904 ± 0·003; b, 5·037 ± 0·002; c, 13·448 ± 0·005 A.; β, 92·74 ± 0·04°, and contains twelve manganese and thirty-six fluorine atoms in general and special positions[1] of space group $C2/c - C^6_{2h}$. The structure is pseudo-rhombohedral, and since the packing of fluorine atoms is midway between close-packed hexagonal and a ReO_3-type defective cubic close-packing, it is classified as a VF_3-type transition-element trifluoride[2]. MnF_6 octahedra are joined by sharing corners, and the lower symmetry of the structure, in comparison with other trifluorides of the first long period, results from the unusual occurrence of three different Mn–F bond-lengths (2·09, 1·91 and 1·79 A.) within each octahedron.

Crystal-field (or ligand-field) theory[3] has been applied recently by Harris, Nyholm and Stephenson[4] to explain the abnormally long Pd–I bonds observed in the distorted octahedral complex $Pd(diarsine)_2I_2$. A similar explanation is now offered for the unsymmetrical bonding in manganese trifluoride.

The magnetic moment[5] of 4·9 Bohr magnetons implies that there are four unpaired electrons in the 3*d* shell of the Mn(III) atom. Three of these occupy the d_ε orbitals, and the remaining electron is probably in a $3d_{z^2}$ orbital. The empty $3d_{(x^2-y^2)}$ orbital points in the direction of four fluorine ions and together with the 4*s* and two 4*p* orbitals forms four hybrid dsp^2 bonds directed towards the corners of a square. The three singly occupied d_ε orbitals offer no repulsion

since they point between the fluorine atoms. The singly occupied $3d_{z^2}$ orbital points along the axis of the remaining two Mn—F bonds and must exert a repulsion. These two fluorine atoms are held either by ionic bonds or by linear hybrid $4p4d$ bonds, an interpretation which is in accordance with the abnormally long bond-length of 2·09 A. The four hybrid $3d_{(x^2-y^2)}4s4p^3$ orbitals are not all exactly equivalent, since the bonds in the plane (1·91 and 1·79 A.) are not of equal lengths.

Neighbouring MnF_6 octahedra are oriented in such a way that a fluorine atom common to both is either equidistant at 1·91 A. from each metal atom or is abnormally distant (2·09 A.) from one manganese atom and at the same time abnormally close (1·79 A.) to the other manganese atom. In this way, the close-packing of distorted octahedra with shared corners is maintained. In terms of classical valency theory, the three different Mn—F bonds might be described as having different covalent and ionic contributions, the ionic contribution increasing with increasing bond-length.

Ligand-field theory also offers an explanation for the unique difference between manganese and its neighbouring metals in their trifluoride structures. Chromium, manganese, iron and cobalt, each in the trivalent state, have electronic configurations as represented in Fig. 1.

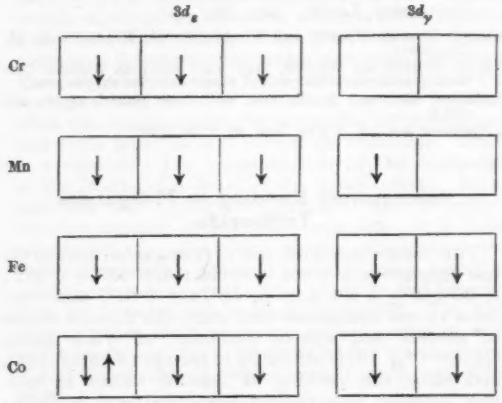

Fig. 1

It is only for manganese, where the electron occupation of the d_γ orbitals is unsymmetrical, that the d_γ interaction with the ligands might be expected to be anisotropic. The iso-electronic Cr(II) fluoride is being examined to see whether a similar effect is observed.

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Reaction between Oxygen and Hot Gold

During the development of an apparatus for measuring the rate of disappearance of oxygen at a pressure of a few microns in the presence of hot metal filaments, gold was used for providing a 'blank'. It was expected that the reaction would be immeasurably slow.

In fact, the oxygen disappeared at a rate which was definite and reproducible (2×10^{-2} μl. cm.$^{-2}$ min.$^{-1}$), and, at a pressure of 3 microns, corresponded to a reaction probability of order 10^{-5} for the impingement of oxygen at room temperature on gold at about 900° C.

Oxygen disappears from the gas phase at a rate which decreases with time. This decrease is connected with the formation of a film on the 'Pyrex' reaction vessel, since if a fresh 'Pyrex' surface is exposed the rate of disappearance of oxygen rises again to its initial value. If the experiment is continued for some hours, the rate of disappearance of oxygen approaches asymptotically to a constant.

The film deposited on the 'Pyrex' walls is at first pink and, when thicker, green, as viewed by transmitted light. X-ray diffraction suggests that the film has the lattice constant of pure gold.

At a pressure of a few microns of oxygen, the rate of deposition of gold on the 'Pyrex' walls is some twenty times that to be expected from the vapour pressure of a pure gold filament and is constant with time. Evacuation of the vessel causes the enhanced evaporation to decay with a time constant of the order of a quarter of an hour.

Since the rate of disappearance of oxygen decreases with time but that of gold transfer is constant, the ratio gold/oxygen increases with time. It seems to vary somewhat from experiment to experiment but is usually of order unity.

If the walls are warmed, the rate of disappearance of oxygen increases (for example, by 50 per cent if the 'Pyrex' is warmed from 20° to 50° C.). The rate also increases if the experiment is stopped and restarted after an overnight period of 'rest'.

Under conditions in which the disappearance of oxygen approached the asymptotic rate, the rate is roughly proportional to the square root of the pressure over the range 1–11 microns.

The reaction-rate increases with the temperature of the filament but does not give a linear Arrhenius plot. At 860° C. a rise of 25° in the filament temperature produces a 30 per cent increase in the rate of reaction.

Vacuum fusion of the gold filament at the end of an experiment failed to recover the oxygen which had disappeared, and X-ray diffraction showed no abnormal lines.

A possible interpretation is that the primary process is the formation of an oxide of gold on the surface of the hot filament. This evaporates and is initially deposited on the 'Pyrex' walls. However, the oxide, when thicker than about a monolayer, is unstable and hence subsequent arrivals break up into gold, which remains, and oxygen atoms. Some of the latter are adsorbed on the surface of the deposit or on impact with the walls. Others recombine and regain the gas phase.

The increased rate of disappearance of oxygen on heating the walls or resting overnight may be due to the migration of oxygen and/or oxide to less accessible sites under the influence of temperature and time.

The work is being continued and will be published in detail later.

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Where is the Earth's Radiogenic Helium ?

AT the estimated 2×10^{20} gm. uranium and 5×10^{20} gm. thorium in the lithosphere, helium should be generated radiogenically at a rate of about 3×10^{9} gm./year. Moreover, the (secondary) cosmic-ray source of helium has been estimated to be of comparable magnitude. Apparently nearly all the helium from sedimentary rocks and, according to Keevil[1] and Hurley[2], about 0·8 of the radiogenic helium from igneous rocks, have been released into the atmosphere during geological times (currently taken to be about 5×10^{9} yr.). Hence more than 10^{20} gm. of helium should have passed into the atmosphere since the 'beginning'. Because the atmosphere contains only $3{\cdot}5 \times 10^{15}$ gm. helium-4, the common assumption is therefore that about 10^{20} gm. of helium-4 must also have passed out through the exosphere, and that its present rate of loss through the exosphere balances the rate of exudation from the lithosphere.

Spitzer[3] has given an exact formulation of the rate of loss of a given component from the exosphere. His result is :

$$L = 4\pi R_0^2\, C n_{0i}\, Y \exp(-Y)\, \frac{R_c}{R_0}\left(1 + \frac{R_c}{R_0 Y}\right)\Big/(6\pi)^{1/2} \qquad (1)$$

where L is rate of loss of the ith component (in atoms/sec.) ; R_0 is radius of the Earth at the surface (in cm.) ; R_c is radius at the base of the exosphere ; C is root mean square velocity ; v_∞ is escape velocity ; $Y = 3{\cdot}2\ (v_\infty/C)^2$; n_{03} and Y_3 apply to helium-3 and n_{04} and Y_4 to helium-4.

At $C = v_\infty$ ($T = 20{,}700°$ K.), therefore, the rate of escape of helium-4 should be $1{\cdot}4 \times 10^{8} \times n_{04}$ gm. atoms per year. Now the experimental evidence from high-altitude studies indicates that hydrogen and helium do not concentrate significantly in the upper atmosphere as has previously been supposed. Since by definition $\Sigma_i n_{0i} = 3{\cdot}0 \times 10^{7}$ atoms/c.c. for all species present at the base of the exosphere, n_{04} may not be appreciably greater than 180 atoms/c.c., giving an escape rate of approximately

$$L \doteq 8 \times 10^{10}\,(20{,}700/T)^{1/2}\,(\exp(1{\cdot}5 - 31{,}400/T) \times 3\,(1 + T/31{,}400)/5 \text{ (gm. helium-4/year)} \qquad (2)$$

Thus even at 20,700° K. where $C = v_\infty$, the escape-rate of helium-4 (about 8×10^{10} gm./yr.) would be only about ten to twenty times greater than that required to maintain steady state with radiogenic and 'cosmogenic' helium, and at the assumed temperature of 1,500° K. at the base of exosphere, the rate of escape of helium-4 would be only about 600 gm./yr., or only about 10^{-7} as great as the replenishment rate from the lithosphere. Spitzer computed, presumably by taking into account a theoretical increase in the concentration of helium-4 in the upper atmosphere, that the rate of escape of helium-3 would be $\{1 - \exp(-1)\} \times 3{\cdot}5 \times 10^{15}$ gm., or $2{\cdot}3 \times 10^{15}$ gm. in 4×10^{15} years at 1,000° K. ; in $2{\cdot}4 \times 10^{7}$ years at 2,000° ; and in about 'geological time' (5×10^{9} years) at 1,500° K. However, this does not take into account the replenishment which in 5×10^{9} years would be about 10^{5} times greater than the total loss from the atmosphere considered by Spitzer. Furthermore, results of rocket studies indicate that the temperature at the base of the exosphere may be even less than 1,500° K. To account for a supposed steady-state atmosphere as regards helium-4, a fluctuating temperature in the exosphere associated perhaps with solar disturbances has therefore been suggested[3]. Since, however, even the unreasonably high steady-state temperature of 7,000° K. would be required to remove the 6×10^{9} gm./yr., any fluctuating-temperature model seems inadequate to explain a theoretical balance between escape and replenishment as regards helium-4 in the atmosphere.

A further complication involves the ratio of helium-3 to helium-4 (^{3}He/^{4}He) shown by Alvarez and Cornog[5], Aldrich and Nier[6] and Coon[7] to be $0{\cdot}3$–$1{\cdot}4 \times 10^{-7}$ in radioactive minerals, $1{\cdot}4$–$1{\cdot}7 \times 10^{-7}$ in natural gas and $1{\cdot}2$–$1{\cdot}3 \times 10^{-6}$ in the atmosphere. Equation (1) gives for the ratio helium-3 to helium-4 in escape gases :

$$\frac{^3\text{He}}{^4\text{He}}\ (\text{escape}) = \left(\frac{4}{3}\right)^{1/2} \frac{n_{03}}{n_{04}}\ \exp\left(\frac{1}{4}\,Y_4\right)\ \frac{Y_3 - R_c/R_0}{Y_4 - R_c/R_0}$$

Since $n_{03}/n_{04} = 1{\cdot}3 \times 10^{-6}$, one thus finds that the ratio helium-3 to helium-4 in the escape gases should be 0·01 if the exosphere temperature is 1,500° K. and 2×10^{-4} if it is 2,500° K. If, therefore, $T = 1{,}500°$ K., one requires an unknown source of about 10^{6} gm./yr. of helium-3 and, if $T = 2{,}500°$ K., a source of about 2×10^{6} gm./yr. to maintain a constant concentration of helium-3 in the atmosphere. The tritium source of helium-3 is only about 100 gm./yr. and the lithospheric source apparently no more than about 800 gm./yr.

Where, therefore, is the 'sink' for about 6×10^{9} gm. helium-4 per year and the 'source' for helium-3 that maintains a ratio of helium-3 to helium-4 (atmosphere) nearly ten times greater than that for the lithosphere, despite a theoretical escape ratio of about 10^{-4}. Perhaps the answer may be found in a non-steady rather than a steady-state solution in which helium-4 is still increasing and in which the relatively high ratio of helium-3 to helium-4 in the atmosphere compared with that in the lithosphere may be the result of terrestrial accretion of meteoric materials which are known to have occluded helium with a very high ratio of helium-3 to helium-4 (up to[8] 0·3). This leads, however, to an 'anomalous' atmospheric chronometry which is, on the other hand, in approximate agreement with the chronometry one obtains from the annual uranium flux in river water (10^{10}–10^{11} gm./yr.) compared with the total uranium present in the oceans (about 10^{15} gm.)[9].

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Simulation of Astrophysical Processes in the Laboratory

A PLASMA gun (or plasma source) has been developed which can project plasmoids[1] (plasma-magnetic entities) across a magnetic field (in a vacuum) at speeds up to 10^7 cm./sec. A Taylor-instability jet[2] produced in a plasma supported against gravity by magnetic field may thus be simulated and studied in the laboratory. The track left by the plasmoid in crossing a magnetic field is luminous[1] because of the recombination light of the ions and electrons which have been left behind as 'debris'. The track may thus be photographed.

If a pressure of a few microns of residual gas is used instead of a vacuum of 10^{-5} mm. mercury, the photo-ionization produced in this gas can give rise to currents that produce an electromagnetic brake on the plasmoid. This braking action not only decelerates the plasmoid but also deflects it into a spiral. The presence of other plasmoids[1] intensifies this process of deceleration and deflexion.

These processes were first documented with time-exposure photographs. A more spectacular demonstration of the effects can be obtained with Kerr-cell photographs such as are shown in Fig. 1, where four plasma sources fire simultaneously across a magnetic field. The pictures show a time-sequence where the four arms wrap themselves up into a spiral, ending in a ring at the end of a 30-μsec. interval. (The plasmoids are composed of deuterium and titanium ions, since the wires of the plasma sources are deuterium-loaded titanium.)

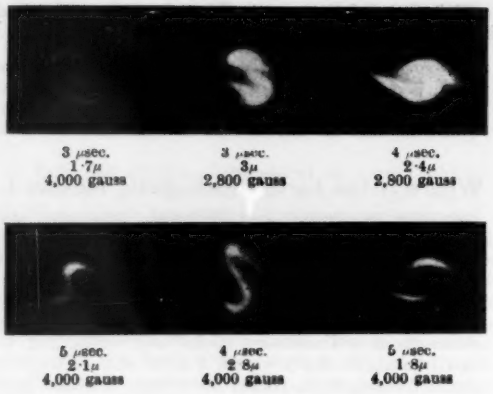

Fig. 2. Kerr-cell photographs (2-μsec. exposure) of the recombination light resulting from the simultaneous firing of two plasmoids across the magnetic fields indicated. Pressures in microns; delay times in μsec. The barred spiral configuration shown here is easily produced over a wide range of parameters

The photographs of Fig. 2 taken with two plasma sources firing simultaneously under various conditions show a type of configuration that is very easy to obtain. These configurations will be recognized by astronomers as barred spirals.

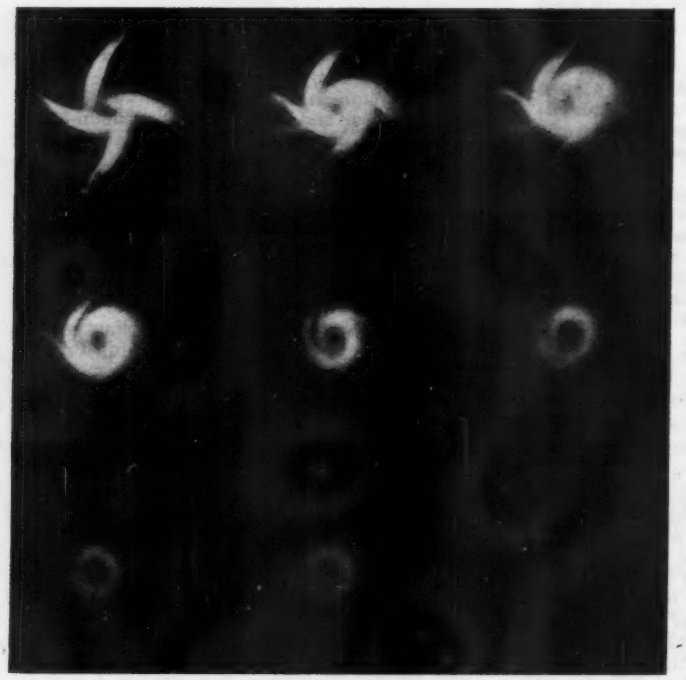

Fig. 1. Kerr-cell photographs (2-μsec. exposure) of the recombination light resulting from simultaneous projection (roughly radially) of four plasmoids across a magnetic field of 4,000 gauss (into the paper) and at a pressure of 2·6 microns. The current in the plasma guns lasts about 0·5 μsec. The guns are arranged symmetrically on the periphery of a 10-cm. diameter ring. Exposures are taken with a sequence of delays of 2, 4, 6, 8, 12, 16, 20, 25 and 30 μsec. The residual gas in the chamber is a combination of deuterium, air and some pump-oil vapour

The conditions for the photographs of Fig. 3 represent higher pressures (and hence more braking action) than those of Figs. 1 and 2. In *a* and *b* of Fig. 3, two plasmoids are stopped short of ever coming in contact with one another. In *c* of Fig. 3, eight plasmoids are projected inward simultaneously, but with the pressure so high that they remain separate and do not coalesce.

We suggest that the processes displayed in these photographs are actually organically related to geometrically similar astrophysical processes, although the laboratory magnetic fields (4,000 gauss) are greater by 10^3, laboratory atom densities (about 10^{14} cm.$^{-3}$) are greater by 10^{12}–10^{13}, laboratory distances (about 10 cm.) are less by 10^{22}, laboratory time-scale (about 10 μsec.) is faster by 10^{22}, laboratory speeds (10^4–10^7 cm./sec.) are comparable, but less by 10–10^3. We suggest that Fig. 1 is representative of the basic processes involved in the formation of a spiral galaxy[3] and perhaps of an individual star; that Fig. 2 is representative of the basic processes involved in the formation of barred spirals known to astronomers; and that *a* and *b* of Fig. 3 represent the formation of binary stars.

(a) 11 μsec. (b) 1·5 μsec. (c) 5 μsec.

Fig. 3. (a) and (b) show two plasmoids fired across a 4,000-gauss magnetic field at pressures (8 and 18 microns) so great that the plasmoids never come into contact. (c) represents eight plasmoids fired at such a high pressure (6 microns) that the plasmoids remain separate

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Crystallographic and Geological Factors in the Growth of Garnets from Central Perthshire

IN the process of mineralogical and petrological studies of the metamorphic rocks in the Central Highlands of Scotland, it has been found that in certain minerals, particularly garnets, there is evidence of interplay of crystallographic and geological factors. Such is seen in the sample which has been collected from central Perthshire (National Grid No. NN 913602). It consists of compact impure graphitic limestone studded with numerous dodecohedral garnets, up to 5 mm. in diameter, but normally of the order of 2 mm. In addition to calcite and garnet, the rock contains an appreciable amount of quartz, muscovite, chlorite and ores. Graphitic dust is concentrated in calcite, muscovite and chlorite.

Most of the garnets consist of two zones. The inner zone, in sections cut parallel to 101, normally shows a radial arrangement of six sectors of clear garnet, without inclusions, interspersed by six zones of garnet with numerous inclusions of calcite and occasional quartz. Such inclusions are dimensionally elongated and possess a parallel orientation which does not change from one sector to the other. The outer zone of each garnet is not subdivided into sectors and has many homogeneously distributed inclusions. These are oriented so that on the diametrically opposite sides of the outer zone they show a deflexion in an opposite sense. In other words, together with the inclusions of the inner zone, they form an (inverted) *S*-shaped trend with the central straight part of the *S* situated in the inner zone and the curved parts in the outer zone. The calcite crystals in the matrix, at the margin of the garnets, are often elongated across the trend of the inclusions in the outer zone. Sometimes a selvage of quartz separates the garnet from the matrix.

The grain size of the inclusions of calcite in the outer zone is generally slightly larger than those of the inner zone. The grain size of the crystals of quartz and calcite in the matrix is larger than that of either set of the inclusions.

Distribution of inclusions in the inner zone conforms to the cases described by Karpinsky[1] and Harker[2], who suggested that they are situated on rhombohedral surfaces converging towards the centre. The fact that the inclusions of the inner zone have similar orientations in different sectors suggests that they have been parts of a pre-garnet fabric and that during the growth of the inner zone of the mineral they have not been deflected. Thus the growth of garnet proceeded under static conditions. Evidently, under such conditions, the purely crystallographic factor of velocity of growth determined those sectors where growth was fast and inclusions were preserved, and those where the slowly growing mineral allowed the dissolution of inclusions. The fact that, despite the relative irregularity of the inclusion-bearing sectors the individual grains are not deflected, signifies that they were not 'brushed aside'. The 'velocity of growth' explanation accords with postulates put forward by Seagar[3], who maintains that the combination of fast initiation and growth on the edges leads to rapid growth of a skeletal crystal with relatively retarded growth of the faces.

In the outer zone, the more or less uniform distribution of inclusions implies that the velocity of growth was generally high enough to ensure the preservation of the inclusions. Since the inclusions in the outer zone show an *S*-shaped trend, the growth of the mineral must have proceeded under dynamic conditions happening simultaneously with rotation of the garnet. Thus the dynamic factor of deformation increases the velocity of growth to such an extent that the purely crystallographic effects, seen in the inner zone of the mineral, are completely overshadowed.

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Importance of Calcium and Magnesium Ions in Phototaxis of Motile Green Algæ

DURING the past year phototactic behaviour has been studied in a number of motile green algæ and dinoflagellates at this laboratory and at Hopkins Marine Station of Stanford University, California[1]. These flagellates swim either towards the light or away from it, depending upon their recent past environment in ways that are far from being understood. When any of the organisms examined was transferred to fresh medium, a negative phototaxis resulted immediately. The direction of response was independent of light intensity. When the organisms were kept in the same medium for some time, from hours to days, their reaction became positive, irrespective of the light intensity.

Some experiments have been performed with *Platymonas subcordiformis* (Wille) Hazen (A. Gibor's strain) directed at analysing the chemical factors

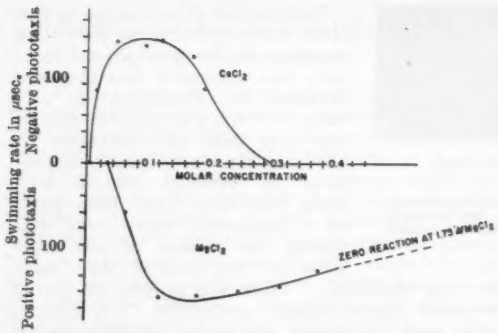

Fig. 1. The phototactic activity in *Platymonas* as measured in 0·5 *M* sodium chloride – calcium chloride solutions (negative phototaxis) and in 0·5 *M* sodium chloride – magnesium chloride solutions, above 0·5 *M* in magnesium chloride solutions (positive phototaxis)

affecting these reactions. It has been shown that carbon dioxide and oxygen in the medium are not primarily responsible for these changes. It has further been shown that Ca^{++} and Mg^{++} are involved and that they are antagonistic in their effect. Ca^{++} causes a negative and Mg^{++} a positive phototaxis. A number of other ions have been tested but so far these have produced no effect.

The effect of Ca^{++} was measured as the negative phototactic activity, recorded as swimming rate, obtained with different concentrations of calcium chloride in a 0·5 *M* sodium chloride–calcium chloride solution; and the effect of Mg^{++} as the positive phototactic activity, recorded as swimming rate, obtained with different concentrations of magnesium chloride in a 0·5 *M* sodium chloride–magnesium chloride solution (at concentrations higher than 0·5 *M* magnesium chloride, magnesium chloride in glass-distilled water was used, sodium chloride being omitted). The results are given in Fig. 1. For Ca^{++} the cells were motionless below 0·005 *M* calcium chloride. With increasing calcium chloride concentration the negative phototactic activity rose to a maximum at 0·05–0·1 *M* and then fell to zero at 0·3 *M*. Above this concentration the cells were motionless. For Mg^{++} the cells showed no movement below 0·035 *M* magnesium chloride. With increasing magnesium chloride concentration the positive phototactic activity increased to a maximum at 0·15–0·25 *M*, then decreased slowly to zero at 1·75 *M*. Above this concentration the cells were motionless.

Fig. 2 shows the results of an experiment in which the calcium chloride/magnesium chloride ratio was altered in a 0·5 *M* sodium chloride–calcium chloride–magnesium chloride solution. The organisms showed

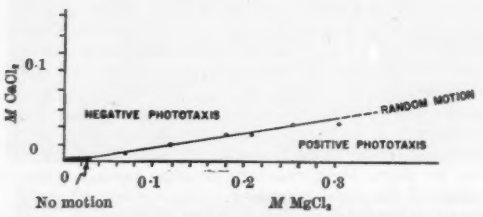

Fig. 2. The phototactic activity in *Platymonas* in 0·5 *M* sodium chloride – calcium chloride – magnesium chloride solutions where calcium chloride – magnesium chloride ratio is altered. Points represent mixtures giving no response

positive phototaxis when the ratio calcium chloride/magnesium chloride was less than 1 : 6, they showed negative phototaxis when the ratio calcium chloride/magnesium chloride was greater than 1 : 6, and they showed random motion when the ratio was 1 : 6.

One of the reasons for the negative phototaxis which always occurred when *Platymonas* was transferred to fresh medium was that the Ca^{++}/Mg^{++} ratio in the medium was 1 : 5; but other factors in addition to this one seem to be important. The reason for the change from negative to positive reaction after some time in the same medium remains unknown, but the *p*H changes which occur during the metabolism are likely to have effect on the phototaxis directly or indirectly.

The theory that the driving power in the flagellates is an 'adenosine triphosphate motor' has recently been suggested by Links[2]. It is also known from a number of experiments that Ca^{++} and Mg^{++} are involved with antagonistic effect in the adenosine triphosphatase activity (for references see Needham[3]). Our experiments with Ca^{++} and Mg^{++} in phototaxis strongly support Links's hypothesis.

Further experiments on phototaxis are in progress. Complete reports will be published elsewhere.

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Factors influencing the Iodine Content of Pasture Herbage

Bourcet[1] reported that wide variation in iodine content occurred among plants growing on the same soil, even among plants of one species. Other workers[2–4] have reported variations in the iodine content of herbage growing on different soils. The extent to which the iodine content of pasture herbage is influenced by soil type, season and botanical composition was not clear, and it has been made the subject of further investigation.

A brief survey of the influence of soil type showed that on five different soils with total iodine contents varying nineteen-fold (135–2,550 μgm. per 100 gm. dry weight) the herbage iodine content of various strains was independent of soil iodine content. It appeared that the amounts of 'available iodine' were similar in all the soils investigated, which ranged in *p*H from 5·0 to 6·0.

When observation was confined to one soil type and when herbage samples were taken from many plants it was found that each strain had a characteristic iodine content. Iodine contents of the pasture strains so far investigated vary over a twenty-fold range, as shown in Table 1.

The iodine content of herbage of most strains investigated was not markedly affected by season.

Table 1. IODINE CONTENTS OF HERBAGE OF PASTURE STRAINS
Data are annual means for monthly samples, bulked according to yield. Strains were grown in randomized plots on one soil type. New Zealand certified strains are denoted by an asterisk

Pasture strain	Iodine content (μgm. Iodine per 100 gm. dry wt.)	Pasture strain	Iodine content (μgm. Iodine per 100 gm. dry wt.)
Perennial ryegrass*	146	Mt. Barker subterranean clover*	24
Italian ryegrass*	85	Broad red clover*	32
Short rotation ryegrass*	31	Montgomery red clover*	47
Cocksfoot*	17	Brown-top	23
White clover*	91	Yorkshire fog	7
Tallarook subterranean clover*	20	*Poa annua*	11
		Poa trivialis	16

It may be concluded that the strain effect is generally the most important of the three factors (strain, soil and season) in determining the iodine status of New Zealand pastures.

From the point of view of the iodine nutrition of grazing animals, the maintenance of the iodine content of herbage of certified strains at moderate or high levels is desirable. Simpson[3] reported that congenital goitre in lambs is associated with herbage iodine contents less than 30 μgm. per 100 gm. dry weight and this has been confirmed by us in four instances.

The data for the certified ryegrass strains are particularly interesting, since New Zealand short-rotation ryegrass, which is derived by selection from hybrids of New Zealand perennial and Italian ryegrasses, has a considerably lower herbage iodine content than either of these strains. On further investigation thirteen perennial ryegrass plants taken at random gave iodine contents ranging from 18·5 to 247·0 μgm. per 100 gm. dry weight. Analyses of plants derived from diallel crosses of four of these plants were therefore made and it was shown that the percentage iodine content of the herbage is a strongly inherited characteristic.

This work will be reported in detail in *Physiologia Plantarum*.

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Effect of Ions of Certain Metals on the Development of Stem Rust in the Wheat Plant

SEEDLINGS of Khapli wheat (*Triticum dicoccum*) are resistant to most races of *Puccinia graminis* var. *tritici*. However, they can be made susceptible by the application of DDT (dichlorodiphenyltrichloroethane) to the leaves[1], by treatment of the plants with maleic hydrazide (private communication from Drs. D. J. Samborski and M. Shaw) and by detaching and floating the leaves on water (private communication from Dr. D. F. Forward). A new method of changing the reaction of the Khapli seedling from resistant to susceptible has been found. The uptake of iron salts by the roots causes a resistant reaction in a normally susceptible plant and it is believed that this finding has economic significance.

Seedlings of Khapli and Little Club wheat were grown on a modified Pfeffer's solution by a method which will be published in detail elsewhere. The seedling leaves of Khapli were inoculated with race 15*B* of stem rust, to which race it is normally resistant. Following an incubation period of 24 hr., various additions were made to the nutrient solution. The addition of 5 gm. of zinc sulphate ($ZnSO_4.7H_2O$) or manganese sulphate ($MnSO_4.4H_2O$) to 2·5 litres of the nutrient solution on the third to the eighth day inclusive after inoculation caused the Khapli leaves to give a susceptible reaction to race 15*B* of stem rust. The solution containing excess of zinc or manganese was left in contact with the plants for only 24 hr. before it was replaced by the original nutrient solution. A similar result has been obtained by using 5 gm. cobalt nitrate ($Co(NO_3)_2.6H_2O$) per 2·5 litres of solution.

Another method was tried in which a much smaller quantity of zinc sulphate was left in the solution continuously. The following concentrations of zinc were used in four separate experiments: 0, 0·11, 0·56, 2·8, 14·0, 70·0 and 350 p.p.m. of zinc ions. Only in the solution with 350 p.p.m. zinc ions did the plants show a susceptible reaction.

The effect of zinc is not specific for Khapli. Seedlings of Mindum and Spelmar (varieties of *Triticum durum*) are normally resistant to race 56 of stem rust, but after treatment with zinc they were susceptible. McMurachy (*Triticum vulgare*), when grown at a temperature continuously below 70° F., is resistant to race 56 but on addition of excess zinc and at the same temperatures the seedling leaves showed a susceptible reaction[2].

Other workers[3] have concluded that at least one form of chlorosis associated with the toxicity of zinc, manganese and cobalt to certain plants is caused by a lack of available iron in the leaves. Indeed, Sideris[4] has shown that the growing of pineapple plants in a nutrient solution with excess manganese results in a root to shoot ratio of iron which is decidedly higher than normal. Since excess amounts of zinc cause iron deficiency and also a breakdown in resistance in the wheat plant, it seemed possible that an application of iron might cause resistance in a normally susceptible plant. By use of ferric sulphate as the salt to supply ferric ions in excess, it was possible to kill rust infections in leaves of Little Club wheat seedlings with concentrations of 40–200 p.p.m. of ferric sulphate ($Fe_2(SO_4)_3.H_2O$) in the nutrient solution. Apparently the ferric ions accumulate in such amounts at the infection site that the rust hyphæ are killed and the infected area becomes dark brown to black in colour. The action of the iron appears to be of an opposite kind to that of zinc and manganese. However, the physiological effect produced by an excess of iron does not appear to lead to hypersensitivity, which is usually associated with resistance. The effect of the iron may be more closely related to an eradicant type of fungicidal action.

The biochemical processes responsible for these effects are not known. The effect of zinc, manganese and cobalt ions is not specific for one genetic type of resistance to rust in the wheat plant. This lack of specificity may mean that the biochemical basis of resistance is the same qualitatively in several different wheat varieties but differs quantitatively.

The results of these experiments suggest the intriguing possibility that the metabolism of iron has

a role in the defensive mechanism of the wheat plant against the rust organism.

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A Powdery Mildew (*Leveillula taurica* (Lev.) Arn.) on Cotton in the Sudan

In December 1955 a powdery mildew hitherto unrecorded in Africa on cotton appeared on several Egyptian (*Gossypium barbadense* L.) as well as American (*G. hirsutum* L.) varieties at Shambat, Khartoum Province. The pathogen, *Leveillula taurica* (Lev.) Arn., is a common parasite upon numerous other cultivated and wild plants in the Sudan[1], becoming more extensive during the winter months. Although the disease was confined mainly to young cotton plants grown in the out-of-season period—for genetical work—and although it was severe only on the cotyledon and first leaves, but scarcely affecting the upper fourth or fifth leaves, the quick spread of this parasite upon the cotton varieties which are most cultivated and highly valued has caused much concern. So far the disease on cotton has not been recorded in the Gezira, where the bulk of the Sudan Egyptian cotton is grown.

From cross-inoculation tests it was demonstrated that the source of infection must have been of local origin, probably from a diseased crop of *Faba bona* Medic (*Vicia faba* L.) which was growing in the vicinity, or else from a ubiquitous shade-loving weed, *Euphorbia heterophylla* L. Several varieties of *G. barbadense* (for example, Domain Sakel and *X* 1730, the two varieties grown in the Gezira and the pump schemes of the Blue and the White Nile) and of *G. hirsutum* became infected when artificially inoculated from diseased leaves of *E. heterophylla* or *F. bona*.

Another interesting aspect of this work, therefore, is the evident tendency of this mildew towards non-specialization. Several other cross-inoculation tests were carried out; for example, from cotton on to *E. heterophylla*, *F. bona*, etc., with positive results in most instances. Since all the artificial inoculations were from lesions or even whole infected leaves, it may be argued that we might have been dealing with a mixed- and not a single-strain inoculum. This possibility, however, is somewhat remote because, so far as is known, physiological races arise primarily as a result of interchange of nuclear material during sexual reproduction. *L. taurica* rarely produces cleistothecia upon its wide range of host species, and the sexual state has not been observed upon any of its hosts (except on *Carthamus tinctorius*) in the Sudan. Furthermore, the even coverage obtained in most cross- and back-inoculations render the possibility of two or more strains being present in every tested sample of inoculum somewhat remote.

These results, which will be published fully elsewhere, do not agree with those of Zwirn[2] or of Kamat and Patel[3], who report that *L. taurica* exhibits highly specialized traits of 'specific' rank. Although it is generally accepted that the powdery mildews, like the rusts, are obligate parasites and that they may have numerous physiological races[4], nevertheless evidence to the contrary has often been cited[4].

It is probable, therefore, that the annual appearance of *L. taurica* on winter crops in the Sudan arises from primary conidial infection from the susceptible weed species, for example, *E. heterophylla*, which 'carry' the disease all the year round.

M. A. Nour

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Nov. 29.

[1] Tarr, S. A. J., "The Fungi and Plant Diseases of the Sudan" (C.M.I. Publication, 1955).
[2] Zwirn, H. E., *Palest. J. Bot., Jerusalem*, **3**, 52 (1943).
[3] Kamat, M. N., and Patel, M. K., *Ind. Phytopath.*, **1**, 153 (1948).
[4] Newton, M., and Cherewick, W. J., *Canad. J. Res.*, C, **25**, 73 (1947).
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Abbreviations for Iodinated Amino-ac'ds and Derivatives from the Thyroid Gland

The use of abbreviations for the designation of compounds on chromatograms or autoradiographs has recently led to some confusion in the thyroid field, because of the variety of symbols used by different workers. At the Ciba Foundation Colloquium last June on the "Regulation and Mode of Action of Thyroid Hormones", a discussion was held in which agreement was reached on suitable symbols for a number of compounds: namely, the iodinated thyronines and tyrosines. This discussion will be published in due course. Meanwhile we desire to direct the attention of those engaged in research on the thyroid to these agreed symbols and to a few additional symbols for compounds which might be found among thyroid hormones or their metabolites.

Thyroxine	T_4	Monoiodotyrosine	MIT
Triiodothyronine	T_3	Tetraiodothyropyruvic acid	KT_4
Diiodothyronine	T_2	Triiodothyropyruvic acid	KT_3
Monoiodothyronine	T_1	Tetraiodothyroacetic acid	TA_4
Diiodotyrosine	DIT	Triiodothyroacetic acid	TA_3

If the writer wishes to distinguish between two isomers, then the symbol can be preceded by numbers indicating the positions of iodine (halogen) atoms in the two benzene rings of thyronine—thus, the three diiodothyronines would be 3 : 5-T_2, 3′ : 3′-T_2 and 3′ : 5′-T_2.

We feel that much would be gained if all workers in this field agreed to use the same symbols for the thyroid hormones, their precursors and derivatives.

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J. Roche
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School of Medicine,
Berkeley 4, California.
Jan. 2.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 28

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. A. D. Booth: "The History and Recent Progress of Machine Translation".* (Second of three lectures on "Aspects of Translation". Further lecture on February 4.)

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Lieut.-Col. G. E. Wheeler: "Recent Developments in Soviet Central Asia".

Tuesday, January 29

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. R. H. Garstang: "The Biography of a Starbeam".*

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. M. Lovett: "The Campaign for Cleaner Rivers".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Scientific Papers.

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. C. A. Keele: "Causes of Pain".* (Seventh of fifteen lectures on "The Scientific Basis of Medicine", organized by the British Postgraduate Medical Federation.)

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, Portland Place, London, W.1), at 7 p.m.—Dr. H. I. Andrews: "The Development of Instruments for Measuring the Performance of Steam Locomotives with the Mobile Testing Plant".

Wednesday, January 30

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. A. R. Michaelis: "Communication of Science by Means of Film".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street Gower Street, London, W.C.1) at 6.30 p.m.—Papers on "Battery Operated Equipment". Mr. R. A. Lampitt and Mr. J. P. Hannifan: "Design of Battery Operated Frequency Modulation Receivers"; Mr. K. E. G. Perry: "The Power Unit Design of Portable Radiation Measuring Instruments".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the LONDON SECTION and the PLASTICS AND POLYMER GROUP, at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. F. A. Paine: "Some Aspects of Food Packaging".

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Economy in Commercial Vehicle Operation".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the SOUTH-WEST ESSEX TECHNICAL COLLEGE CHEMICAL SOCIETY, at the South-West Essex Technical College, Forest Road, London, E.17), at 7 p.m.—Mr. R. Lait: "Some Aspects of Inorganic Peroxy Compounds".

Thursday, January 31

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 11 a.m.—Discussion on "Viability of Mammalian Cells and Tissues After Freezing", opened by Dr. A. S. Parkes, F.R.S.

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. L. S. Penrose, F.R.S.: "The Uncommon Case of the Porcupine Man".*

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.15 p.m.—Prof. F. Bergel: "Recent Advances in Cancer Research".*

Friday, February 1

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion on "The Use of Natural and Artificial Tracer Elements in Geophysical Research". Chairman: Prof. P. A. Sheppard. Speakers: Prof. H. C. Urey, Dr. L. H. Cooper and Dr. N. G. Stewart.

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion Meeting on "The Effects of Low Temperature on Mammals and Their Tissues". Chairman: Dr. A. S. Parkes, F.R.S.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir William Pugh, F.R.S.: "The Geological Map of Great Britain".

Saturday, February 2

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Kenneth Oakley: "Early Man's Use of Fire".*

BRITISH INTERPLANETARY SOCIETY (in the Tudor Room, Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Wing Commander P. Latham: "Accelerations in Flight".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade A (with a degree in physics or A.Inst.P., and preferably with industrial, research or teaching experience), at the Technical College of Monmouthshire, Crumlin—The Director of Education, County Hall, Newport, Mon. (January 31).

ASSISTANT EXPERIMENTAL OFFICERS (with a pass degree in botany or other suitable qualification), for posts in cytology, grass and clover breeding—The Registrar, Welsh Plant Breeding Station, University College of Wales, Aberystwyth (January 31).

ASSISTANT (Scientific) to be mainly responsible for photographic work—The Secretary, Welsh Plant Breeding Station (University College of Wales), Plas Gogerddan, near Aberystwyth (January 31).

LECTURER and ASSISTANT LECTURER (with an honours degree in physics or physical chemistry or mechanical engineering, and preferably with industrial or teaching experience) IN PAPER TECHNOLOGY in the Department of Textile Chemistry, to undertake research and to teach paper technology—The Registrar, The Manchester College of Science and Technology, Manchester 1 (February 1).

SIR ALAN COBHAM RESEARCH FELLOW IN AERONAUTICS, to carry out research in one of the following subjects: (*a*) aircraft noise and structures, (*b*) hypersonics, (*c*) helicopter vibrations; (*d*) jet flap investigations, or (*e*) numerical methods applied to wing design—The Secretary and Registrar, The University, Southampton (February 7).

LECTURER IN MEDICAL STATISTICS—The Registrar, The University, Manchester 13 (February 9).

PHYSICAL CHEMIST, Scientific Officer grade (with a first- or second-class honours degree or equivalent) at the Food Investigation Low Temperature Research Station (D.S.I.R.), Cambridge, to study separation processes based on electrodialysis, including the properties of ion-selective membranes and investigation of behaviour of industrial solutions in multi-compartment cells—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.730/6A (February 9).

SENIOR AGRICULTURAL ECONOMIST (with a good degree in economics or agriculture with economics, together with experience in farm management and advisory work) IN THE DEPARTMENT OF AGRICULTURAL ECONOMICS—The Registrar, King's College, Newcastle-upon-Tyne (February 9).

RESEARCH FELLOW (with a degree in veterinary science), for work in animal viruses under the direction of the Head of the Department of Microbiology—The Secretary, The Queen's University, Belfast (February 15).

LECTURER (with special qualifications in applied mathematics) IN MATHEMATICS—The Registrar, The University, Manchester 13 (February 16).

RESEARCH FELLOW IN THE NUCLEAR ENGINEERING LABORATORY of Queen Mary College (University of London), to carry out research on fundamental fluid motion and heat transfer problems associated with the use of liquid fuels in nuclear reactors—The Registrar, Queen Mary College, Mile End Road, London, E.1 (February 16).

LECTURER or ASSISTANT LECTURER IN PHYSICS at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (February 22).

LECTURER IN THE COMPUTING LABORATORY—The Registrar, University of Durham, 1A Kensington Terrace, Newcastle-upon-Tyne 2 (February 23).

LECTURERS IN MATHEMATICS—The Registrar, King's College, Newcastle-upon-Tyne (February 23).

CHAIR OF STATISTICS within the Department of Pure Mathematics—The Registrar, The University, Birmingham 15 (February 27).

CHAIR OF STATISTICS in the University of the Witwatersrand, Johannesburg South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, February 28).

DIRECTOR OF THE COMPUTING LABORATORY—The Secretary of University Court, The University, Glasgow (February 28).

LECTURER or ASSISTANT LECTURER IN PURE MATHEMATICS; a LECTURER or ASSISTANT LECTURER IN APPLIED MATHEMATICS; and LECTURERS (2) or ASSISTANT LECTURERS (2) IN THE SUB-DEPARTMENT OF COMPUTATION—The Secretary and Registrar, The University, Southampton (February 28).

LECTURER or ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Secretary, The University, Exeter (March 1).

ASSISTANTS (2) (female, preferably with a degree in biology or horticulture or equivalent qualification) principally for field experiments on fruit crops carried out by the plant pathology, entomology and plant protective chemistry sections—The Secretary, East Malling Research Station, near Maidstone, Kent (March 2).

LECTURER IN CHEMICAL ENGINEERING at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, March 31).

LECTURER (with an honours degree and experience in research or in clinical work) IN PSYCHOLOGY at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, March 31).

IMPERIAL CHEMICAL INDUSTRIES FELLOWS FOR RESEARCH IN PHYSICS, CHEMISTRY, COLLOID SCIENCE, BIOCHEMISTRY, ENGINEERING, METALLURGY, PHARMACOLOGY, CHEMOTHERAPY or related subjects—The Secretary-General of the Faculties, University of Cambridge, The Old Schools, Cambridge (April 30).

AGRICULTURAL SUPERINTENDENT (with a university degree in agriculture, horticulture or a natural science (which includes botany) or the Diploma of the Imperial College of Tropical Agriculture, and at least two years suitable postgraduate training or experience) in British Guiana, for the development of the cocoa industry (duties include the supervision of nurseries and propagation centres, field trials and experiments, etc.)—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/30/011.

ASSISTANT PROFESSOR OF PHARMACOLOGY—The Dean of Medicine, University of Alberta, Edmonton, Alberta, Canada.

ELECTRONIC ENGINEERS or PHYSICISTS (with, or obtaining, a first- or second-class honours degree or equivalent, with experience or interest in radio, radar and communications; instrumentation for telemetry and other measurements; electronic devices; application of advanced techniques to other fields, for example, armament) at Ministry of Supply Research and Development Establishments, chiefly at Malvern, Worcs; Farnborough, Hants; and Sevenoaks, Kent—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.514/6A.

GRADUATE (metallurgy, chemistry or physics) IN THE INFORMATION DEPARTMENT, for work dealing with every aspect of the recording and transmission of information on the extraction, manufacture and uses of non-ferrous metals and their alloys—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

MASTER (with an honours degree) to teach Chemistry to advanced level; and a MASTER (with an honours degree) to teach Mathematics to advanced level—The Headmaster, Bristol Grammar School, Bristol 8.

RESEARCH ASSISTANT (young graduate in one of the biological sciences, and preferably with an interest in, and knowledge of, histochemistry and bone metabolism) IN THE PHYSICS DEPARTMENT, to assist in research upon the effects of high energy radiation upon normal bone and bone tumours by means of autoradiography, microradiography and histochemistry—The House Governor, Westminster Hospital, St. John's Gardens, London, S.W.1.

SENIOR LECTURER (with a degree in mining engineering or equivalent and not less than five years teaching experience at a British University) IN MINING ENGINEERING at the University of Rangoon—The Ministry of Labour and National Service (A.S.12), Almack House, King Street, London, S.W.1, quoting A.12/BUR/437/TCS.

SENIOR TECHNICIAN and/or TECHNICIAN IN THE CLINICAL PATHOLOGICAL LABORATORY—The Secretary, The National Hospitals for Nervous Diseases, Queen Square, London, W.C.1.

TECHNICIAN (trained in bacteriology) IN THE VIRUS REFERENCE LABORATORY, Colindale—The Director, Central Public Health Laboratory, Colindale Avenue, London, N.W.9.

REPORTS and other PUBLICATIONS

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Proceedings of a Symposium on Optical Design with Digital Computers, held in the Physics Department, Imperial College, London, S.W.7, June 5, 6 and 7, 1956. Pp. viii+93. (London: Imperial College, 1956.) 10s. [2311

Institute of Personnel Management. Annual Report of the Council, 1955–56. Pp. 20. (London: Institute of Personnel Management, 1956.) [2611

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1955–56. Kenya. Pp. 14. 9d. Sudan. Pp. 28. 9d. (London: Empire Cotton Growing Corporation, 1956.) [2611

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The New Scientist. No. 1 (22. November, 1956). Pp. 68. 1s. weekly. Subscription rates: Inland and Overseas, 60s. a year; 30s. for six months. Special rates: Canada, 7.50 dollars a year; U.S.A., 8.50 dollars a year. (London: Harrison, Raison and Co., Ltd., 1956.) [3011

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Agricultural Research Council: Soil Survey Research Board. Soil Survey of Great Britain. Report No. 8, 1955. Pp. iii+45. (London: H.M. Stationery Office, 1956.) 5s. net. [312

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World Health Organization. Technical Report Series, No. 110: Expert Committee on Insecticides—Sixth Report. Pp. 88. (Geneva: World Health Organization; London: H.M. Stationery Office, 1956.) 3s. 6d.; 2 francs; 0.60 dollars. [2611

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Metropolitan Life Insurance Company. Statistical Bulletin. Vol. 37 (October 1956): The Birth Rate—Recent Trends and Outlook. Pp. 12. (New York: Metropolitan Life Insurance Company, 1956.) [312

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Smithsonian Miscellaneous Collections. Vol. 131, No. 8: The Geology and Vertebrate Paleontology of Upper Eocene Strata on the North-Eastern Part of the Wind River Basin, Wyoming. Part 2: The Mammalian Fauna of the Badwater Area. By C. Lewis Gazin. Pp. iii+35+3 plates. (Publication 4257.) Vol. 131, No. 9: Breeding and Other Habits of Casqued Hornbills (*Byconistes subcylindricus*). Pp. v+45+6 plates. (Publication 4259.) (Washington, D.C.: Smithsonian Institution, 1956.) [312

Kungl. Lantbruks- Högskolans Annaler, Vol. 22. (Annals of the Royal Agricultural College of Sweden.) Pp. iv+488. (Uppsala: Kungl. Lantbruks- Högskolans, 1956.) [312

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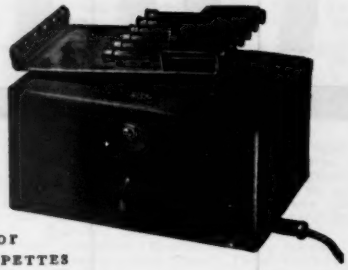

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